Project: REN_EZ1_23_IVS_PCU

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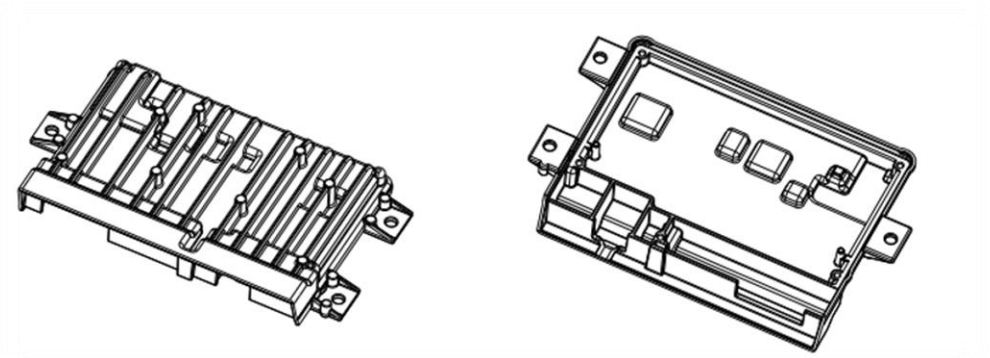

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1 VERSION HISTORY:

Change reasons (CR):

1 HW Change
2 SW Change
3 Change requirements on behalf of the customer
4 Continental TEMIC change requirement
5 TBD (to be defined)
6 Unclear formulation
7 Editing changes (spelling mistakes, layout, etc. without any content changes)

Version	Date	Author	Comment, Description
0.1 (AA)	03.02.2022	Madalina Davidescu	1st draft
0.2 (AA)	14.03.2022	Madalina Davidescu	Update version history; Update first page with general info; Update checkers list; Test flow updated – number of EUTs for endurance test and series tests; Chapter 11.2:Physical analysis– Add details for cross section; Chapter 13.2:Test case activation – Insert table; Chapter 16.1:CL/00 Thermal inertia characterization test – Added Thermocouples placement; Chapter 16.11:CL/13:Check of saturation temperature; Chapter 17.2:CH/02: Water tightness test - Added test for characterization and EUT test position; Chapter 18.1:LT/00: Temperature equivalent evaluation- insert thermocouples placement; Chapter 14.3:VI/07 insert details about CP1 and CP2 profile;
1.0 (AA)	02.05.2022	Madalina Davidescu	Valid after email received from the customer (28.04.2022); Chapter 9.2.2 – new fixation according the data from Renault 2022-04-27; Update“test case activation“; Update ch. 14.1 VI/01 Resonance investigation- added the measurement points; Update ch. 17.1 CH/01- added test points definition; Update ch. 17.2 CH/02- added acceptance criteria;
1.1 (AA)	17.05.2022	Madalina Davidescu	Update document name; Added document number;

TABLE OF CONTENT

GENERALS

1.1 Introduction

This Qualification Test Plan describes the required measurement and tests for the devices **REN_EZ1_23_IVS_PCU,** to validate or to characterize its electric and mechanical behaviour in the specified environment.

REN_EZ1_23_IVS_PCU (PCU: Physical Computing Unit) is the main central EUT of RENAULT electronic architecture platform called FACEazy. This platform is composed of the PCU and a Physical Interface Unit (PIU).

This document answers to:

- CUSTOMER DESIGN SPECIFICATION: RNDS-C-00515 v3.0 : Basic physicochemical environmental specifications of electronic parts;

RNDS-C-00515_3_0.pdf

- International standardization as well as CONTINENTAL's expertise concerning environmental testing and Reliability engineering.

1.2 Purpose

The customer shall carefully check this document and return a signed copy of its agreement.

The purpose of this document is to describe the DV/PV environmental qualification program that must be successfully completed in order for Continental and the customer to consider the assembly qualified for use in the end application for which it was designed. This specification was developed in accordance with the customer environmental test specifications and international standardization and is valid for the following sample variants:

Continental name	Continental part number identification	Customer number identification	No. of parts to be tested
REN_EZ1_23_IVS_PCU	AAA2223810000	284B74098R	Please check in the test flow

Change to this document has to be mutually agreed between customer and Continental Automotive.

1.3 Perimeter of responsibility of Continental on connector plug

As regards tests where connector plug is necessary (example: corrosion…), the perimeter of responsibility of Continental is limited to the EUT equipped with its pinheader connector. It is also the perimeter for test investigation, analysis and corrective action. Connector plug is not part of the study and not in the perimeter of Continental's responsibility and tasks.

Fastening and screwing of the EUT on the bench will not be representative of the real vehicle fastening.

2 REFERENCED STANDARDS AND DOCUMETS

Originator	Version/Date	Description of document
Customer	RNDS-C-00515 v3.0 (2019-09-16)	RENAULT NISSAN DESIGN SPECIFICATION (RNDS)Part/module generic specifications, containing RNDS-C-00515 v3.0; Title:BASIC PHYSICOCHEMICAL ENVIRONMENTAL SPECIFICATIONS OF ELECTRONIC PARTS
	DEL5_BMIR_V5643_2007-0010_RFQForm_V6p5_ENV_EMC_PCU (2021-11-21)	RFQ-Form_Environmental__ENV_EMC
International Standards	ISO 16750-1 (2006-08-01)	Road vehicles — Environmental conditions and testing for electrical and electronic equipment —(Part 1:General)
	ISO 16750-3 (2007)	Road vehicles — Environmental conditions and testing for electrical and electronic equipment (Part 3: Mechanical loads)
	ISO 16750-4 (2010-04-15)	Road vehicles — Environmental conditions and testing for electrical and electronic equipment (Part 4: Climatic loads)
	ISO 20653 (2013-02-15)	Road vehicles — Degrees of protection (IP code) — Protection of electrical equipment against foreign objects, water and access.
	IEC 60068-2-1 Ab (2007-03)	Environmental testing - Part 2-1: Tests - Test A:Cold
	IEC 60068-2-2 Bd (2007-07)	Environmental testing - Part 2-2: Test B: Dry heat
	IEC 60068-2-6 (2007-12-01);	Environmental testing – Part 2-6: Tests – Test Fc: Vibration (sinusoidal)
	IEC 60068-2-14 Na (2009-01)	Basic Environmental Testing Procedures; Part 2: Tests; Test N: Change of temperature
	IEC 60068-2-14 Nb (2009-01)	Basic Environmental Testing Procedures; Part 2: Tests; Test N: Change of temperature
	IEC 60068-2-27 (2008-02-01)	Environmental testing – Part 2-27: Tests – Test Ea and guidance: Shock
	IEC 60068-2-30 (2005-08-01)	Environmental testing - Part 2-30: Tests - Test Db: Damp heat, cyclic
	IEC 60068-2-31 (2008-05)	Environmental testing - Part 2-31: Tests - Test Ec: Rough Handling Shocks, primarily for equipment-type specimens
	IEC 60068-2-38 (2009-01)	Environmental testing. Part 2: Tests. Test Z/AD: Composite temperature/humidity cyclic test
	IEC 60068-2-60 Ke (2015-06-18)	Environmental testing - Part 2: Tests - Test Ke: Flowing mixed gas corrosion test - Edition 3.0
	IEC 60068-2-64 (2019-10-01)	Environmental testing - Part 2-64: Tests - Test Fh: Vibration, broadband random and guidance
	IEC 60068-2-78 (2012-10-01)	Environmental testing - Part 2-78: Tests - Test Cab: Damp heat, steady state
	DIN 75220 (1992-11-01)	Ageing automobile components in solar simulation units
	DIN EN 13018 (06.2016).	Non-destructive testing - Visual testing - General principles;

3 DEFINITIONS & ABBREVIATIONS

ABBREVIATION	TRANSCRIPTION
a	Acceleration [m.s-^{2}]
CAN	Controller Area Network
DUT	Device Under Test
DV	Design Validation
ECU	Electronic Control Unit
ETS	Environmental Test Specification
EUT	Equipment Under Test
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
ISO	International Organization for Standardization
ISO/TS	International Organization for Standardization /Technical Specification
IP code	International Protection code
f	Frequency [Hz]
FSC	Functional Status Classification
KL_15	Clamp 15, meaning “Ignition Power”
KL_30	Clamp 30, meaning “Permanent Power Supply”
LED	Light Emitting Diode
OM	Operating mode
PWM	Pulse Width Modulation
PSD	Power Spectral Density
PV	Product Validation
QP	Qualification Program
QL	Qualification Laborator
QMP	Quality Manager Project
RH	Relative Humidity
RMS	Root Mean Square
RT	Room Temperature
RTU	Retractable tow bar unit
t	Time
T	Temperature
TCM	Transmission Control Module
TEL	Test Engineer Product Launch
TPL	Technical Project Leader
TF	Test Flow
TRM	Trailler Module
SPA	Scalable Platform Architecture
PPAP	Production Part Approval Process
VI	Visual inspection

4 TEST SELECTION

4.1. Global Test plan defined between Renault and Continental

The communication for environmental tests has been based on mainly following document "DEL5_BMIR-V5643-2007-0010_RFQ_Form_V6p5_ENV_EMC_PCU_20211021".

Deviation and restriction list for the environmental validation plan compare to RNDS-C-00515 v3.0.

Tests	Test required	Operating mode	Continental Comments
CH/02 Liquid tightness (Water test)	-	1.2	Characterization only (orientation in the vehicle)
CL/13 Check of Saturation Temperature	yes	3.2	N/A
LT/00 Self heating temperature measurement	yes	3.2	N/A
CL/00 Thermal inertia characterization test	yes	1.1	N/A
CL/01 Thermal shock endurance test	yes	1.1	3 PCB only + 3 normal samples
CL/02 Thermal shock pre-ageing test (50 cycles)	yes	1.2	N/A
CL/03 Warm storage	yes	1.1	N/A
CL/04 Cold storage	yes	1.1	N/A
CL/06 Climatic sequence test	yes	3.2	n/a
CL/07 Temperature range (steps) test	yes	3.2	N/A
CL/08 Warm operation test	yes	3.2	N/A
CL/09 Cold operation test	yes	3.2	N/A
CL/10 Cold and low pressure storage test	yes	1.1	N/A
CL/15 Continuous humidity test	yes	1.2	Initial measurement of the EUT only at RT.
CH/01 Solid tightness	yes	1.2	N/A
CH/02 Liquid tightness (Water test)	yes	1.2	Agreed position for X and Y axis ;
CH/08 Fluid corrosion	yes	1.2	N/A
CH/09 Salt spray with humidity functional endurance test	yes	1.2	N/A
CH/12 Corrosive atmosphere	yes	1.2	N/A
VI/01 Resonance investigation- resonance point detecting test	yes	1.2	Operating mode 1.2. instead of 3.2. Test for characterization only.
VI/05 Resonance -point 1h oscillation test	yes	3.2	VI/01 parts can not be used for VI/05 due to PCB accelerometer destructive placement.
VI/07 Random vibration endurance test	yes	3.2/1.2	N/A
MS/01 Free fall test	yes	1.1	N/A
MS/02 Mechanical shocks – resistance to impact during assembly test	yes	1.1	N/A
MS/03 Mechanical shocks – Resistance to collision impact test	yes	3.2	N/A
MS/07 Mechanical shocks – Shocks from the road test	yes	3.2	N/A
MS/10 Brackets and fasteners strength test	yes	1.1	N/A
MS/11 Terminal strength test	yes	1.1	N/A
LT/01 Thermal cycling life test	yes	1.2	Test performed with operating mode 1.1 instead of 1.2.
LT/02 Constant humid heat life test	yes	3.2	N/A
LT/03 Thermal life test	yes	3.2	N/A
Physichal analysis -cross section	yes	-	N/A
Whiskers test	yes	-	N/A
Disassembly examinations	yes	-	N/A

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5 GENERAL REQUIREMENTS FROM RENAULT

5.1 Warranted mileage to be covered by testings

220 000 km or 15 years

5.2 ECU mounting location description (for LT/xx tests)

ECU mounting location	Description	Examples of ECU
I	Inner/under instrument panel, under rear parcel board (inside trunk room), under seat, center console inside	BCM, Airbag ECU, APB, radio, ECM
II	Roof trim inside, steering pad inside, instrument panel, Rear parcel board upper face, any portions the temperature of which rises remarkably by solar radiation	Sunroof ECU, display for back seat
III	Body side in engine compartment	USM, ABS,ESP, ECM
IV	Engine body directly	ATCU

5.3 Degree of protection against ingress of foreign objects (First code digit)

First code digit / supplementary letter	Short description	
	Protection against ingress of	Requirements
0	not protected	None
1	solid foreign objects diameter ≥ 50 mm	Ball with diameter 50 mm shall not penetrate completely
2	solid foreign objects diameter ≥ 12,5 mm	Ball with diameter 12,5 mm shall not penetrate completely
3	solid foreign objects diameter ≥ 2,5 mm	Rod with diameter 2,5 mm shall not penetrate completely
4	solid foreign objects diameter ≥ 1,0 mm	Wire with diameter 1,0 mm shall not penetrate completely
5K	dust	Dust shall only penetrate in quantities which do not impair performance and safety
6K	dust	Dust shall not penetrate

5.4 Degree of protection against ingress of water (Second code digit)

Second code digit / supplementary letter	Protection against ingress of	Requirements
0	not protected	None
1	water drips	Vertical drips shall not have any harmful effects
2	water drips with enclosure inclined by 15°	Vertical drips shall not have any harmful effects
3	water spray	Water spray which sprays against the enclosure from any direction at a 60°angle shall not have any harmful effects
4	splash water	Water which splashes against the enclosure from any direction shall not have any harmful effects
4K	splash water with increased pressure	Water which splashes against the enclosure from any direction with increased pressure shall not have any harmful effects
5	high-velocity water	Water which is directed against the enclosure from any direction as a jet shall not have any harmful effects
6	strong high-velocity water	Water which is directed against the enclosure from any direction as a strong jet shall not have any harmful effects
6K	strong high-velocity water with increased pressure	Water which is directed against the enclosure from any direction as a strong jet with increased pressure shall not have any harmful effects

5.5 ECU durability level

Durability level		Assurance grade (for information)
High	H	B
Medium	M	C
Low	L	D

5.6 Low temperature value

Tmin	Storage	Operating	
		Safety + Start ECUs (The car will be able to start and be safety)	Other ECUs (All the ECU's function must work)
Europe	-40°C	-40°C	-30°C
America (North and South), China	-40°C	-40°C	-35°C
Japan, Asia	-30°C	-25°C	-25°C
Others	As agreed upon		

5.7 High temperature value

Tmax	Installation severity	Storage	Operating	
			Safety + Start ECUs	Other ECUs
Passenger room and Trunk room	A1	70°C	70°C	60°C
	A2	85°C	85°C	70°C
	A3	85°C	85°C	80°C
	C*	As agreed upon		
Engine room	B1, B2, C	As agreed upon Tmax and Tovershoot (Tovershoot = Tmax + 20°C is a worst case)		

6 OPERATING MODE

The electric, electronic and mechatronic components and systems will be operated in different operating modes during their service life, which shall be simulated correspondingly during the tests. Details concerning the operating modes, operating loads (e.g. actuation, bus activity, bus messages, original sensors, original actuators or replacement circuitry) and the necessary boundary conditions shall be coordinated between the buyer and supplier and documented.

Operating Mode	**Electrical State**
Operating mode 1 - No voltage is applied to the device under test.	
1.1	not connected to a power supply system.
1.2	connected according to the vehicle installation, but no voltage applied.
Operating mode 2 - The DUT is electrically operated with the test voltage U_B (12V) as in a vehicle with shut-off engine and with all electrical connections made.	
2.1	System/ component functions are not activated (e.g. sleep mode)
2.2	Systems/components with electric operation and control in typical operating mode.
Operating mode 3 - The DUT is electrically operated with test voltage U_A (14V) with all electrical connections made	
3.1	System/ component functions are not activated
3.2	System/ components with electric operation and control in typical operating mode.

7 FUNCTIONAL STATUS CLASSIFICATION

Acceptance criteria (according to ISO16750-1:2018(E);Ch. 6): This element describes the functional status of a EUT during and after a test. The minimum functional status shall be given for each test.Unwanted operations of the EUT are not allowed in any of the following classes.Vehicle manufacturer and Continental shall specify operations that are not allowed.

Six operating classes define the behavior of the equipment submitted to the various environment constraints.

The classes reported below comply with the Annex "Classification of the degree of seriousness of misoperations" of ISO Standard 7637, Section 1.

Functional status classification	
Class A	All equipment/system functions are fulfilled normally (100 % functional) during and after the constraint.
Class A‘	All equipment/system functions are fulfilled normally (100 % functional) after the constraint (this class only concerns equipment whose operational check is not required during the tests).
Class B	All equipment/system functions are fulfilled normally during application of the constraint; however, one or several of them may be out of the specified tolerances. After application of the constraint, all functions automatically return within standard limits. The memories shall remain in compliance with Class A.
Class C	One equipment/system function is not fulfilled normally during application of the constraint but automatically returns within normal limits on completion.
Class D	One equipment/system function is not fulfilled normally during application of the constraint and does not automatically return within standard limits on completion, and the equipment/system is re-initialized through a simple action on the part of the user.
Class E	One or several equipment/system function(s) is (are) not fulfilled normally during and after application of the constraint and it is impossible to restore correct operation without repairing or replacing the equipment/system.

(**) “Specified limits” is preferred to “normal limits” as written in ISO 16750-1.

8 CLASSIFICATION OF GRAVITY LEVEL

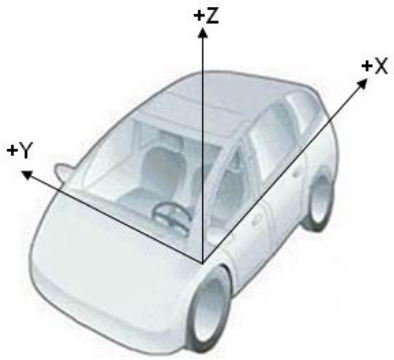
The types of undesirable effects which may occur during and after the tests of this product specification are defined by three gravity levels.

Level	Effects	Definitions
0	No	
1	Minor	Negligible damage and without risks for man and the environment
2	Major	Without important damage or major risk for man and the environment

The system or equipment shall be designed so that no electromagnetic disturbance can be the cause of a catastrophic effect.

9 DRAWING/ PRODUCT IMPLEMENTATION IN VEHICLE

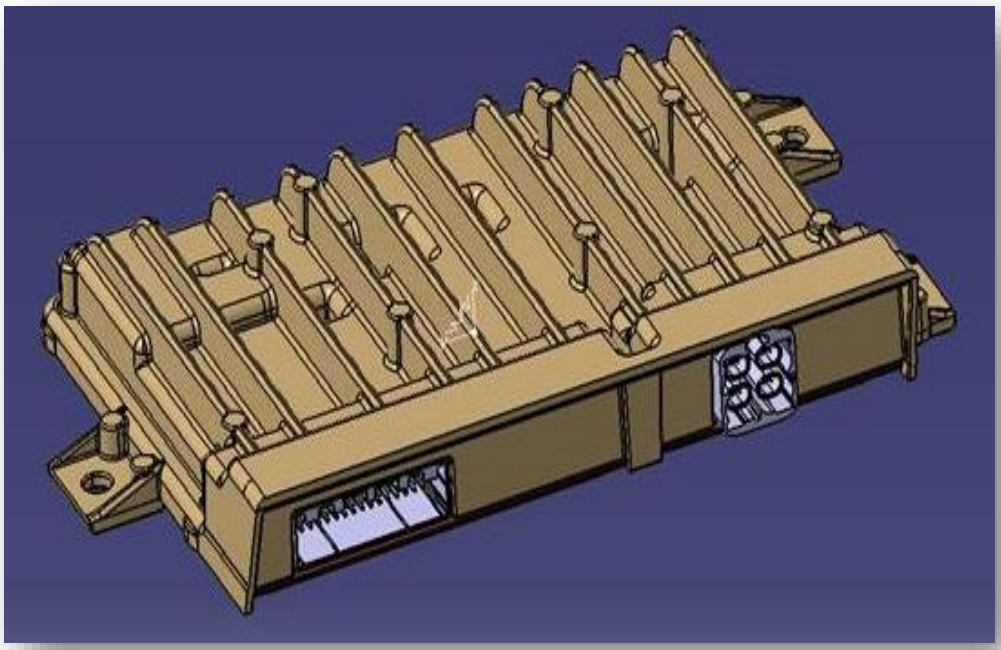
9.1 Vehicle directions



9.2 FACEasy PCU implementation in vehicle

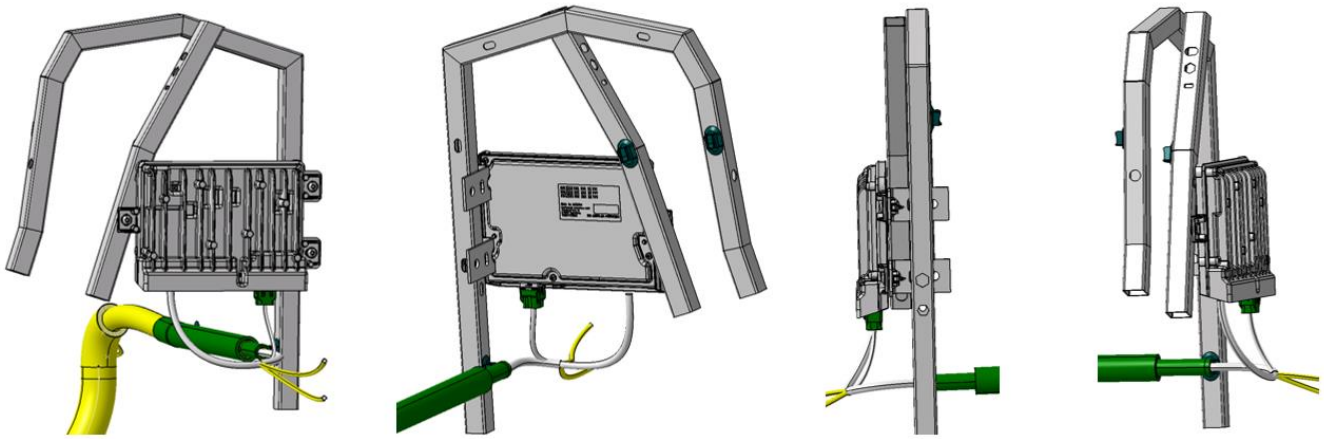
Project application drawing and definition of equipment axis in vehicle.

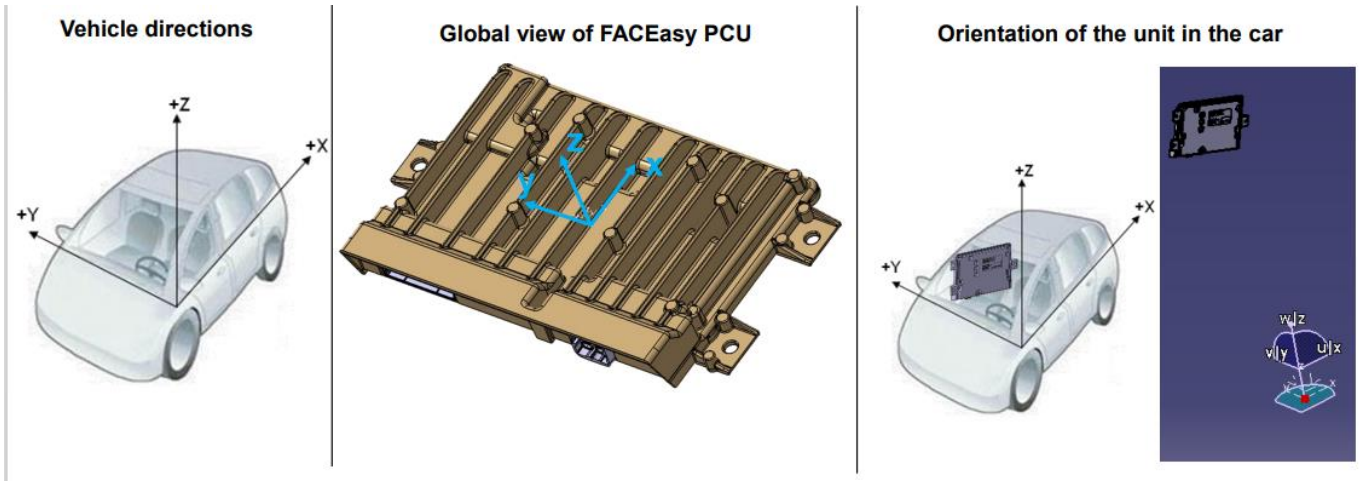
9.2.1 Global view of FACEasy PCU product

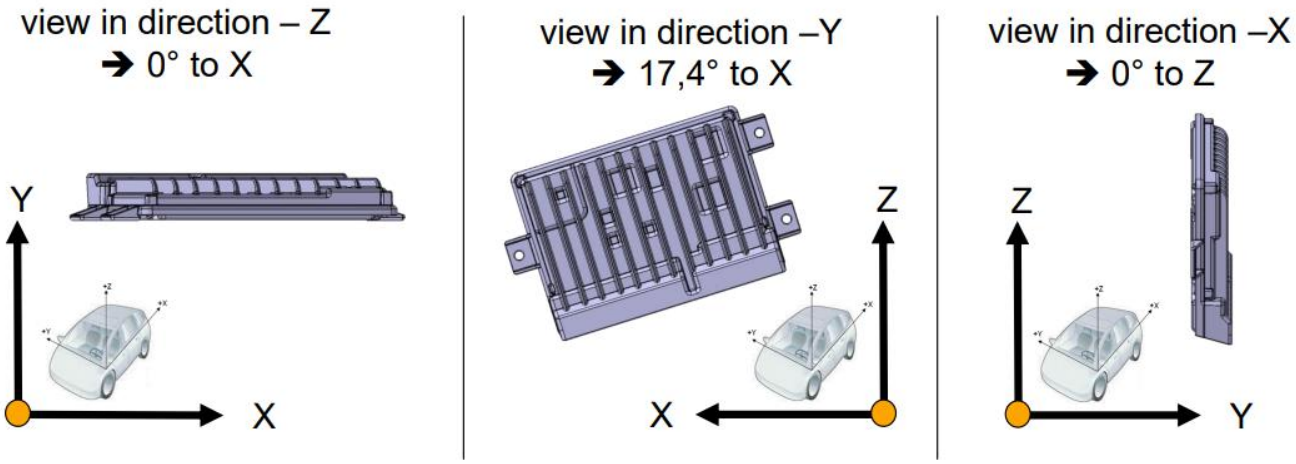


9.2.2 FACEASY PCU orientation in the vehicle

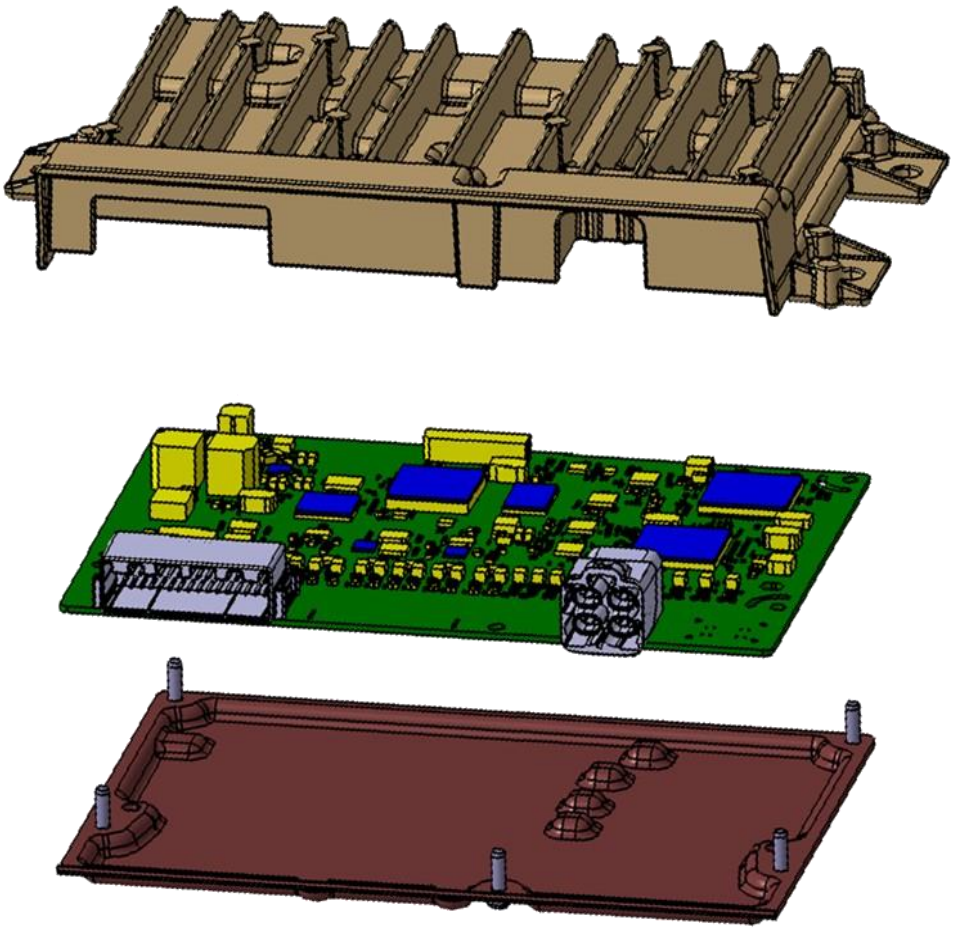
(according the data from Renault 2022-04-27);







9.2.3 Views of the FACEazy PCU product from side, top & exploded



9.2.4 Sample equipped/Mechanical view

Housing material

The housing material will be AlSi12Cu1 (Fe).

Dimensions

X × Y × Z = 206 x 126,2 x 29,4 mm

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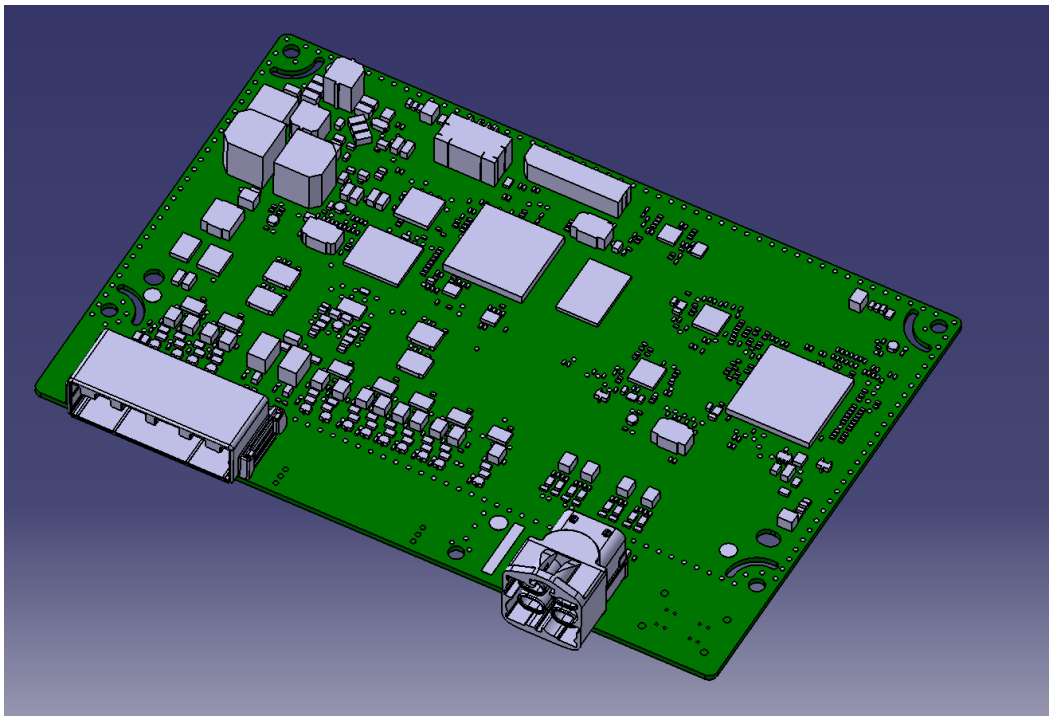
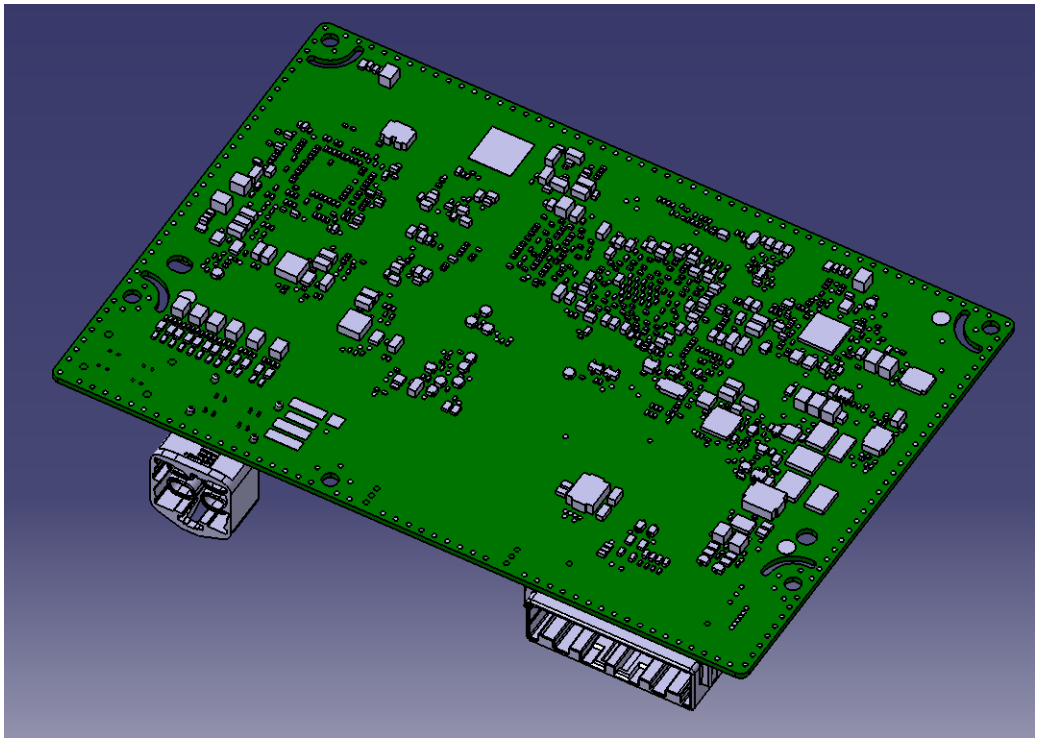
Mechanical construction – TOP VIEW



Mechanical construction - BOTTOM VIEW



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9.2.5 Pinning overview

Abbreviation	Description	Comment
KL30	+ Power Supply	
KL15	active when ignition is active, will be not distributed on the HCP_GEN2 PCB design !!!	
KL31	Ground Signal	
CAN	CAN FD Interfaces	CAN high and Low of one CAN Should be in one Line - CAN00-05 should be on Connector X2000.
CANT	CAN Termination	
ETH	100B-T1 Ethernet	Ethernet Configuration always needs to be
OBD	100B-TX Ethernet	
GETH	1000B-T1 Ethernet	
LIN	Lin Interfaces	Integrated Lin's should be on Connector X2000.
FR	FlexRay Interfaces	
DEBUG	Debug interfaces (e.g. UART)	
Purple Color	Interface is not populated for the FACEazy MY23 variant !	
Red Color	The second power supply circuit will be not distributed on the FACEazy MY23 PCB design !!!	
NC	Not Connected	

ETH_P	ETH_N
ETH_N	ETH_P

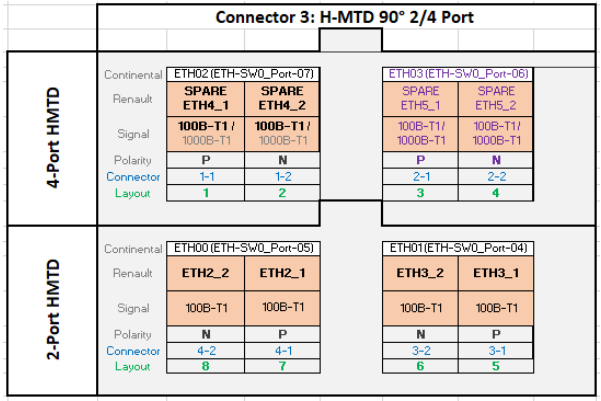
or

ETH_N	ETH_P
ETH_P	ETH_N

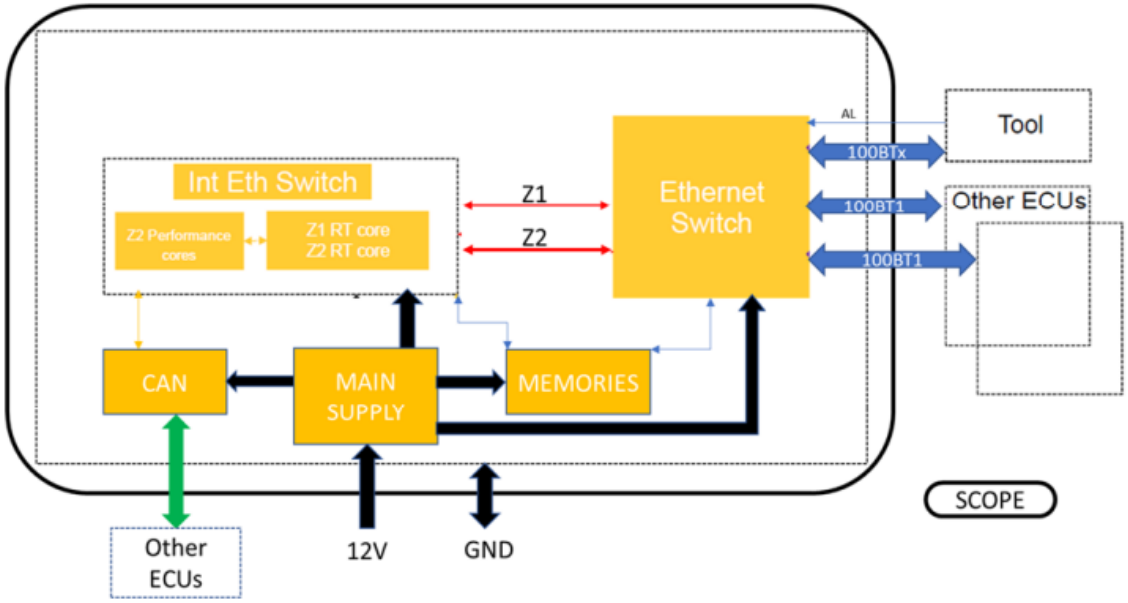
Renault FACEazy MY23 GW - 32-pin Connector Definition

Connector A = X2000: 32 Pin

16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
KL30_0 (MAIN_0)	CAN03_H	CAN03_L	CAN00_H	CAN00_L	CAN01_H	CAN01_L	NC	LIN00	LIN01	NC	DEBUG _TX	DEBUG _RX	NC	OBD_TX_P	OBD_TX_N
32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17
CANT00_H	CANT00_L	KL31_0 (GND)	CAN02_L	CAN02_H	CAN05_L	CAN05_H	NC	LIN02	LIN03	CAN04_L (OBD)	CAN04_H (OBD)	ETH_OBD _ACTIVATION	SHIELD _OBD	OBD_RX_N	OBD_RX_P



9.2.1 PCU Block diagram



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9.3 Connector and cable harness

Harnesses will be built by Continental.

9.4 Mounting

Test, if not otherwise specified, shall be done in car mounting representative position.

Refer to each test specification for product position, number of fixation points, screws type and torque.

10 GENERAL TESTING REQUIREMENTS

10.1 General test conditions

All EUTs have to be clearly marked by the development department. Use of original connectors and similar cable harnesses is mandatory. Deviations need to be mentioned in the test order.

Unless otherwise specified, all tests shall be performed at:

Standard atmospheric conditions for measurement and tests	
Temperature	15°C to 35°C
Relative Humidity	60 % ±15 %
Air Pressure	96 kPa ± 10 kPa.
General Definitions	
Room Temperature (RT)	(23 ±5)°C
Low temperature storage	-40°C
High temperature storage	+70°C
Low temperature operating	-40°C
High temperature operating	+70°C
Minimum Power Supply (U_{min})	9 (± 2%)V
Nominal Power Supply (U_{nom})	14 (± 2%)V unless otherwise specified in the test description
Maximum Power Supply (U_{max})	16V (± 2%)
Temperature Reference Point	Ambient temperature (chamber temperature)
Thermal equilibrium	A component that is kept at a constant ambient temperature under defined operating conditions is deemed to have attained complete thermal equilibrium at that point in time at which the temperature will not change by more than ±3 °C at any point of the component over the further course of time.

Default tolerances during qualification	
Tolerance	**Parameter**
± 5%	for voltages (except supply voltages) and currents
± 10%	for time slots, distance, energies, powers
± 10%	for capacitor, resistor, inductances, impedances
± 2°C	for temperatures

10.2 Test samples

Test samples, for each test file leg, shall be :

- Clearly marked by the development department;
- In a clean and new condition;
- With all parts in place and mounted in the manner stated by the product specification.

10.3 Sample variants

Different variants/levels of products will be used for testing :

- The Design Validation will be performed on BDV samples
- manufactured in prototype production according to a prototype flow chart.

- The Process Validation will be performed on C samples
- manufactured on serial production according to a serial flow chart.

- Variants according to Customer industrialization requests, BOM (2nd suppliers sources) and R&D project development (full equipped) will be managed in the DV and PV Flow chart documents.

10.4 Sub-contracted test (Sibiu, Romania)

ACCREDITATION CERTIFICATE - NO. LI 1255.pdf

ANNEX NO.1 TO ACCREDITATION CERTIFICATE - NO. LI 1255.pdf

11 VALIDATION TESTS

11.1 PARAMETRIC TESTS

The parametric test provides a complete assessment of the ECU's health and evaluates the functional characteristic of EUTs in accordance with Life time test (LTT).

Before starting the environment test, the EUT's shall pass the preceding Function test (as indicated in test flow) and may not show any mechanical damage on the visual inspection.

11.1.1.1 Initial Measurement Tests (IM_Test)

Shall be performed on each EUT at the beginning of test file with valid test equipments released for DV & PV.

Electrical function test, all functions and test cycle, with test voltage and temperatures. Mechanical function check according to Test Cycle described below. EUT is tested at three temperatures (RT- room temperature, Tmin - low temperature and Tmax- high temperature) and at nominal voltage ranges according with table below:

Temperature (°C)	**T_{min} (-40°C)**	**RT**	**T_{max} (+70°C)**
Voltage (V)	Unom =14±0,2V	Unom =14±0,2V	Unom =14±0,2V

*****NOTE:**

For **CL/15 test** the Initial Measurement test (IM_Test) will be performed at room temperature (RT) and nominal voltage (Unom =14±0,2V) only.

Samples shall be stored at least during 20 minutes at every temperature before testing.

11.1.1.2 Intermediate Measurement Tests_Small (IntM_Small_Test)

Similar to initial electrical parametric test but performed at room temperature only.

To be performed when testing is located neither at the beginning nor at the end of a test file.

11.1.1.3 Intermediate Measurement Tests_Large (IntM_Large_Test)

Shall be performed at end of each test with valid test equipments released for DV & PV.

Electrical function test, all functions and test cycle, with test voltage and temperatures. Mechanical function check according to Test Cycle described below. EUT is tested at three temperatures (RT- room temperature, Tmin - low temperature and Tmax- high temperature) and at nominal voltage ranges according with table below:

Temperature (°C)	**T_{min} (-40°C)**	**RT**	**T_{max} (+70°C)**
Voltage (V)	Unom =14±0,2V	Unom =14±0,2V	Unom =14±0,2V

11.1.1.4 Final Measurement Tests (FM_Test)

Shall be performed at end of test file on each EUT with valid test equipments released for DV & PV.

Electrical function test, all functions and test cycle, with test voltage and temperatures. Mechanical function check according to Test Cycle described below. EUT is tested at three temperatures (RT- room temperature, Tmin - low temperature and Tmax- high temperature) and at nominal voltage ranges according with table below:

Temperature (°C)	**T_{min} (-40°C)**	**RT**	**T_{max} (+70°C)**
Voltage (V)	Unom =14±0,2V	Unom =14±0,2V	Unom =14±0,2V

Samples shall be stored at least during 20 minutes at every temperature before testing.

11.1.2 Functional Confirmation Test (FCT)

Functional confirmation test is performed on each EUT during test for which monitoring is required.

For each test, an activation and check scenario are defined.

11.1.3 Software used to operate samples

Unless something else specifically written, software programmed into EUT and in use for all monitored trials is a test software (not applicative customer software).This software (called "2022.CW18.bup_ez1 Software") is developed by Continental Software Platform Toulouse especially for validations and verifications, and is specZific to the device to FACEASY PCU.

11.2 PHYSICAL ANALYSIS

Visual inspections:

The visual inspections can be external and/or internal inspections depending on the requirements mentioned in the related test to perform.

Unless otherwise specified, EUT are visually inspected at R.T. and compared with samples in clean and new condition to detect any major or/and minor non conformance.

- Any deformation, damage, scratch, crack, color change, migration, whisker, oxidation shall be reported and documented;
- Marking shall be legible;
- Labels shall have good adhesion;
- Any ingress of liquid or dust shall be reported and documented.

Mechanical Parameters:

The mechanical parameters will be evaluated at R.T.

- Check samples for deformations (Bending of the housing, twist of the housing and dents in the housing).
- Check housings for damages like scratches, cracks or color changes.
- Shake samples to check for loose parts inside the housing.

For the intermediate check : Standard requirement is to be found in test sheets as : External visual inspection does not show any mechanical damage

Disassembly examinations:

After the test, the EUT shall be taken out of water and disassembled to examine for traces of water, fluid or corrosion. If traces of water, fluid or corrosion penetration are found, an examination shall be made to locate the portions through which water penetrated into the EUT.

This investigation it's applicable after CH/02, CH/08, CH/12 tests.

Cross section and Whiskers investigation:

This inspection must be performed on unsealed ECUs, with dedicated optical devices. Firstly, a minimum magnification of x 50 is required to inspect the risky area (fine pitch components or connectors for example). Then, a SEM inspection is necessary to validate the length of the whiskers.

Micro sections:
- CL/01: DV (after 200 cycles) on 2 parts & PV (after 1000 cycles) on 2 parts
- LT/01: DV (after VI/07 15min) on 2 parts & PV (after VI/07 15min) on 2 parts
- LT/03: DV on 2 parts & PV on 2 parts
- MS/11: DV only on connectors on 2 parts & PV only on connectors on 2 parts

Whiskers:
- CL/01: (1000 cycles) during PV on 1 part
- LT/02: (1000 h) during PV on 1 part

Whisker inspection shall be executed on all connectors placed in the previous test. The inspection shall be performed using a microscope or/and SEM capable to investigate the surface of the specimen.

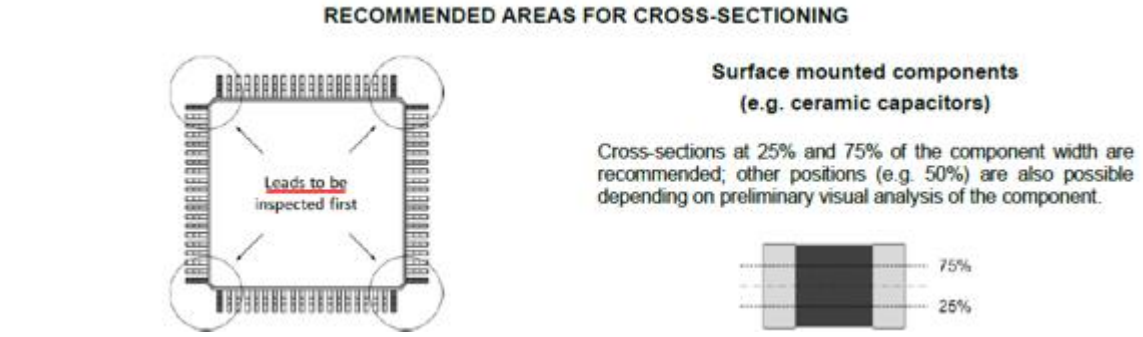
The SEM shall be equipped with a handling system capable to tilt and rotate the samples
Note 1: SEM will be used only in case whisker identified with length >30µm.

Note 2: The test will be performed with opening the housing for PCU samples. The whisker length definition of IEC 60068-2-82 Annex A shall be followed. Whisker longer than 10 µm shall be reported with a picture. The maximum permissible whisker length is 50 µm.

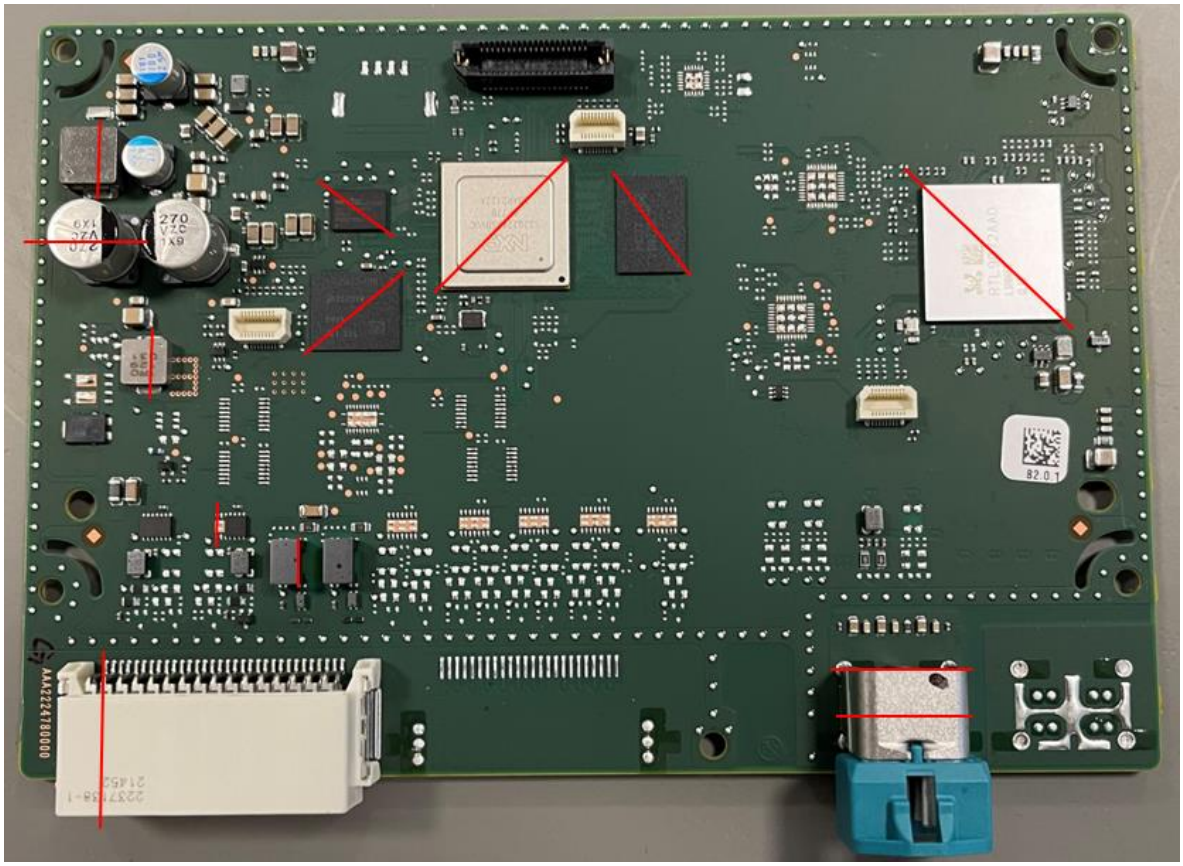
Unless otherwise specified, perform cross-sections of solder joints representative to:

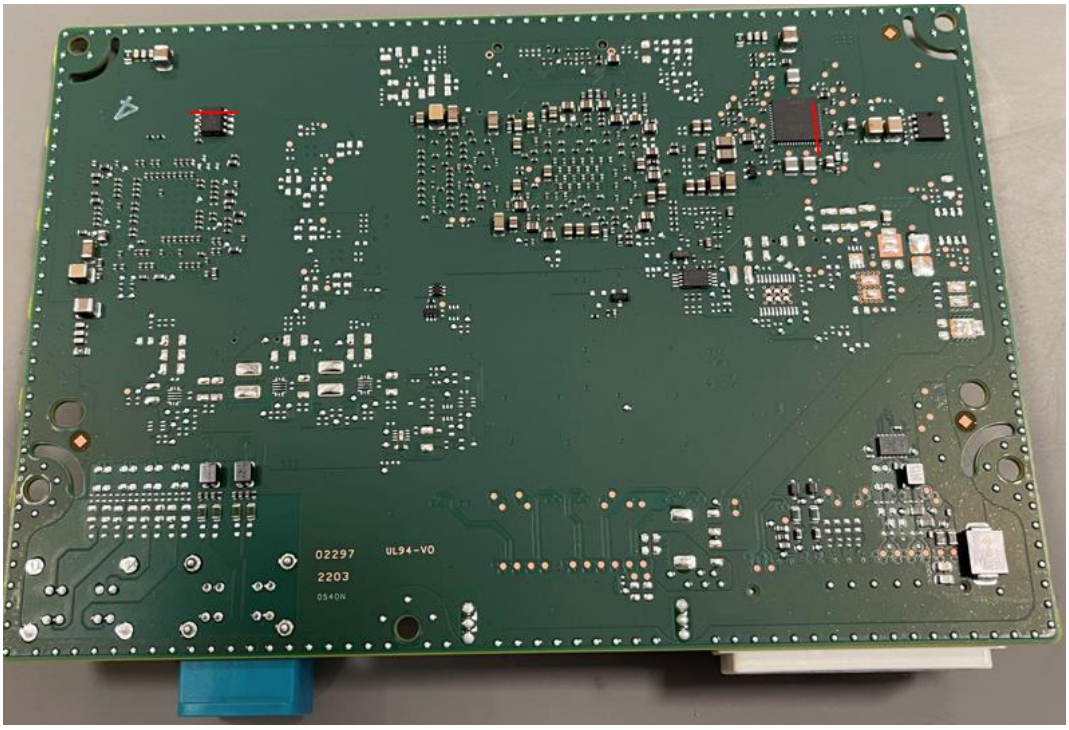
- Each kind of soldering process (e.g. reflow, wave, selective, and reworked, etc.);
- Each specific technology (e.g. BGA, QFN, PLCC, press fit, etc.);

Special attention shall be paid to points stressed by important differentials coefficient of thermal expansion, located at corners of SMD parts with large diagonal lengths, big mass parts, through-hole parts, vias, with the smallest diameter.



Cross sections are performed on each component family to be representative of all components on the product (based on different type of package or semiconductor technology) and also based on component weight. The purpose is to check the quality of each type of solder joints.





The cross section will be done on all failed EUT part and on 2 EUT of the group in case of good parts. The location of cross section is defined for following components and location on PCB:

Top face:

- 1 cross section on 16 pins of 32 ways connector X2000.
- 2 cross sections on 2 pins Ethernet HMTD connector X2003.
- 1 cross section on Main Microcontroller IC10000 (bga525 package) for the general and overall software functionality.
- 1 cross section on IC Memory IC10001 (bga200 package) for LPDDR4 memory of the UP S32G functionality.
- 1 cross section on IC Memory IC12000 (bga24 package) for OSPI NOR Flash memory of the UP S32G functionality.
- 1 cross section on IC Memory IC12003 (bga153 package) for EMMC memory of the UP S32G functionality.
- 1 cross section on IC System Controller Digital ASSP IC20000 (bga489 package) for Ethernet Switch#0 (ETH-SW0) functionality.
- 1 cross section on IC Bus Driver IC40006 (dfn8 package) for CAN-Bus functionality.
- 1 cross section on Coil L4001 for Power-Supply-Filtering functionality.
- 1 cross section on Coil L5001 for Power-Supply-Management-IC (PEMIC - VDD_3V3_CONST) functionality.
- 1 cross section on Ethernet Transformer TR22000 for OBD-ETH AFE 100Base-TX functionality.
- 1 cross section on Capacitor C4005 for Power-Supply-Filtering functionality.

Bottom face:

- 1 cross section on IC Power-Supply-Management-IC (PEMIC) IC5000 (qfn56 package) for the UP S23G power supply functionality.
- 1 cross section on IC Memory IC21000 (so8 package) for ETH-SW0 boot configuration functionality.

12 Test Reports

The test report must contain at least the following information :

- Report reference: Name, version, date, name of testing engineer.
- EUT reference: Project, project phase, EUT identification, HW & SW version.
- The R/N test specification reference with the test conditions and parameters (Voltage supply conditions, orientation of EUT, tightening torque, harness fixation, temperature, etc.).
- The detailed procedure used for the test.
- Facilities: list of facilities used for test.
- Set-up test diagram or pictures (photos with details).
- Susceptibility threshold and required limits.
- Calibration results (curve or values): power supply (+VBatt).
- Type of sensors (real or simulated and their descriptions and characteristics).
- Data: All parameters measured during the test (functional and others like temperature, humidity, etc.) and fault indicator on CAN and voltage characteristics during the test.
- Clear status of the result of test.

Results: Comparison between parameter measured and test criteria with comments is necessary of course, with the test status. Do not forget to report this one in the ANPQP N°26 synthetic validation plan document

13 Environmental Validation Execution

The following document is applicable for DV and PV tests.

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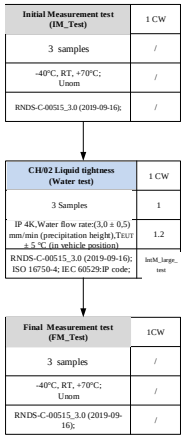
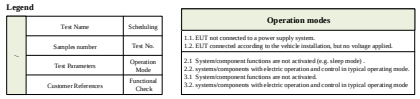
13.1 Test flow for DESIGN VALIDATION

Project support tracking	
Project name:	REN_EZ1_23_IVS_PCU
Test flow:	Test Flow for DV/PV
Editor:	Madalina Davidescu
Department:	VNI CE SYS EU1 IAS GD6
Date:	14.03.2022
Version:	V02(Draft)

FACEazy PCU – DV/PV tests Flow-Chart

CHARACTERIZATION TESTS



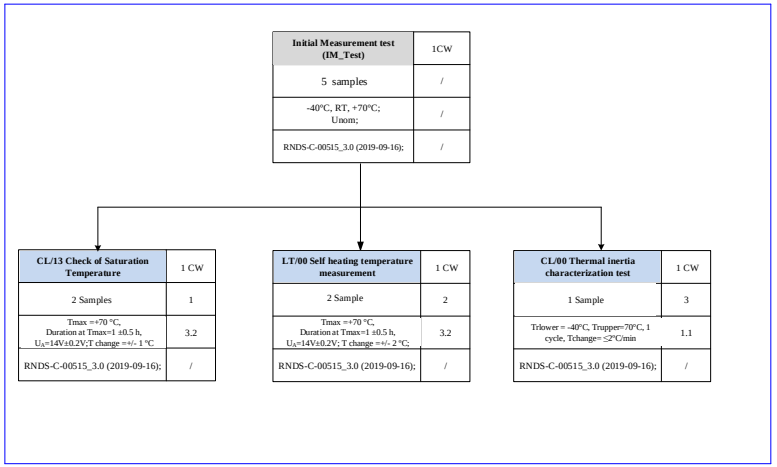


Project: REN_EZ1_23_IVS_PCU

Project support tracking	
Project name: **Test flow:**	REN_EZ1_23_IVS_PCU Test Flow for DV/PV
Editor: **Department:**	Madalina Davidescu VNI CE SYS EU1 IAS GD6
Date: **Version:**	14.03.2022 V02(Draft)

FACEazy PCU – DV/PV tests Flow-Chart

CHARACTERIZATION TESTS



Legend

~	Test Name	Scheduling
	Samples number	Test No.
	Test Parameters	Operation Mode
	Customer References	Functional Check

Operation modes
1.1. EUT not connected to a power supply system. 1.2. EUT connected according to the vehicle installation, but no voltage applied.
2.1 System/component functions are not activated (e.g. sleep mode) . 2.2. systems/components with electric operation and control in typical operating mode. 3.1 System/component functions are not activated. 3.2. systems/components with electric operation and control in typical operating mode.

Project: REN_EZ1_23_IVS_PCU

FACEazy PCU – DV/PV tests Flow-Chart

Project support tracking	
Project name:	REN_EZ1_23_IVS_PCU
Test flow:	Test Flow for DV/PV
Editor:	Madalina Davidescu
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Date:	14.03.2022
Version:	V02(Draft)

STAND ALONE TESTS

Initial Measurement test (IM_Test)	1CW
25 samples	/
-40°C, RT, +70°C; Unom	/
RNDS-C-00515_3.0 (2019-09-16);	/

IntM_Small_Test

CH/01 Solid tightness	1 CW
3 Samples	1
IP 42, 20 solid foreign objects diameter ≥ 1,0mm; Wire with diameter 1,0 mm shall not penetrate	1.2
RNDS-C-00515_3.0 (2019-09-16); ISO 20653(2013-02-15); ISO 16750-4(2010-04-15)Ch.5.10	IntM_large_test

CL/02 Thermal shock pre-ageing test (50 cycles)	1 CW
6 Samples	2
Tmin= -40 (°C); Tmax= 70(°C); Ncycles=50; soak time=15 min; transition time<30s;	1.2
RNDS-C-00515_3.0 (2019-09-16); IEC 60068-2-14 Na (2009-01-01); ISO 16750-4(2010-04-15)Ch.5.3.2;	IntM_large_test

V1/01 Resonance investigation-resonance point detecting test	1 CW
1 Sample	5
Freq:10 Hz to 1 000Hz, 9.8m/s2 peak, sweeping cycle =33min, X,Y,Z axis, RT	1.2
RNDS-C-00515_3.0 (2019-09-16);	N/A

V1/05 Resonance -point 1h oscillation test	1 CW
3 Samples	6
At each resonance frequency found, 29,43 m/s2,1 hour per axis (vertical, lateral, longitudinal), Unom, RT	3.2
RNDS-C-00515_3.0 (2019-09-16); IEC 60068-2-6 (2007-12-01);	N/A

CL/08 Warm operation test	1 CW
3 Samples	7
Start at RT, 1°C / min; Topmax = +70 °C, Unom;	3.2
RNDS-C-00515_3.0 (2019-09-16); IEC 60068-2-2 (2007-07-01);	IntM_large_test

CL/15 Continuous humidity test	6 CW
3 Samples	12
Temp =40 °C, RH=95%±5%, 1000 h, intermediate test after 300h and 600h at RT;	1.2
RNDS-C-00515_3.0 (2019-09-16);	IntM_large_test

CL/03 Warm storage	1 CW
3 Samples	13
Tmax= 70(°C);RT, soak time= 48h	1.1
RNDS-C-00515_3.0 (2019-09-16); IEC 60068-2-2 B	IntM_large_test

MS/10 Brackets and fasteners strength test	1 CW
3 Samples	16
±X,±Y,±Z, force applying 200 N, RT	1.1
RNDS-C-00515_3.0 (2019-09-16);	IntM_large_test

CH/08 Fluid corrosion	1 CW
3 Samples	3
24h/fluid, Coca-Cola and water-based;	1.2
RNDS-C-00515_3.0 (2019-09-16);	IntM_large_test

CH/12 Corrosive atmosphere	2 CW
3 Samples	4
10 days, method 4; (75 ± 3) % RH	1.2
RNDS-C-00515_3.0 (2019-09-16); IEC 60068-2-60 Ke: Flowing mixed gas corrosion test	IntM_large_test

CL/09 Cold operation test	1 CW
3 Samples	8
Start at RT, 1°C / min; Topmin = -40 °C, 12 cycles ON-OFF, 24h, Unom	3.2/1.2
RNDS-C-00515_3.0 (2019-09-16); IEC 60068-2-1;	IntM_large_test

CL/04 Cold storage	1 CW
3 Samples	14
Tmin= -40(°C);RT, soak time= 24h	1.1
RNDS-C-00515_3.0 (2019-09-16); EC 60068-2-1	IntM_large_test

MS/11 Terminal strength test (only connector)	1 CW
3 Samples	17
(Tmin) -40°C, RT and Tmax; 10 times in each temperature; Speed 20 mm/min, 120 N	1.1
RNDS-C-00515_3.0 (2019-09-16);	IntM_large_test

CL/07-a Temperature range (steps) test	1 CW
3 Samples	9
Tmin=-40 °C; Tmax=+70 °C; step 5°C, Umin, U nom and Umax;	3.2
RNDS-C-00515_3.0 (2019-09-16); IEC 60068-2-2;	IntM_large_test

MS/01 Free fall test	1 CW
3 Samples	15
1 m, 2 number of drops, concrete floor, ±X,±Y,±Z	1.1
RNDS-C-00515_3.0 (2019-09-16);	IntM_large_test

Final Measurement test (FM_Test)	1CW
3 samples	10
-40°C, RT, +70°C; Unom;	/
RNDS-C-00515_3.0 (2019-09-16);	/

CL/07-b Temperature range (steps) test	1 CW
3 Samples	11
Tmin=-40 °C; Tupper=Tmax + 10°C; step 5°C, Umin, U nom and Umax;	3.2
RNDS-C-00515_3.0 (2019-09-16); IEC 60068-2-2;	IntM_large_test

Final Measurement test (FM_Test)	1CW
25 samples	/
-40°C, RT, +70°C; Unom;	/
RNDS-C-00515_3.0 (2019-09-16);	/

Physical analysis	1CW
Samples to be decided by project team after the tests	/
-	/
-	/

Legend

-	Test Name	Scheduling
	Samples number	Test No.
	Test Parameters	Operation Mode
	Customer References	Functional Check

Operation modes
1.1. EUT not connected to a power supply system. 1.2. EUT connected according to the vehicle installation, but no voltage applied.
2.1 System/component functions are not activated (e.g. sleep mode) . 2.2. systems/components with electric operation and control in typical operating mode. 3.1 System/components functions are not activated. 3.2. systems/components with electric operation and control in typical operating mode

Designed by : Madalina Davidescu	Date: 17.05.2022	Depart: AN CE SYS EU1 IAS GD6	Sign:
Continental	Document name: Qualification Program	Project: REN_EZ1_23_IVS_PCU	
	Document : QP_ENV_REN_EZ1_23_IVS_PCU_ALL_0048_V1.1 (17.05.2022)		Pages:30
Continental Iasi (AN) 2022			

Project: REN_EZ1_23_IVS_PCU

Project support tracking	
Project name:	REN_EZ1_23_IVS_PCU
Test flow:	Test Flow for DV/PV
Editor:	Madalina Davidescu
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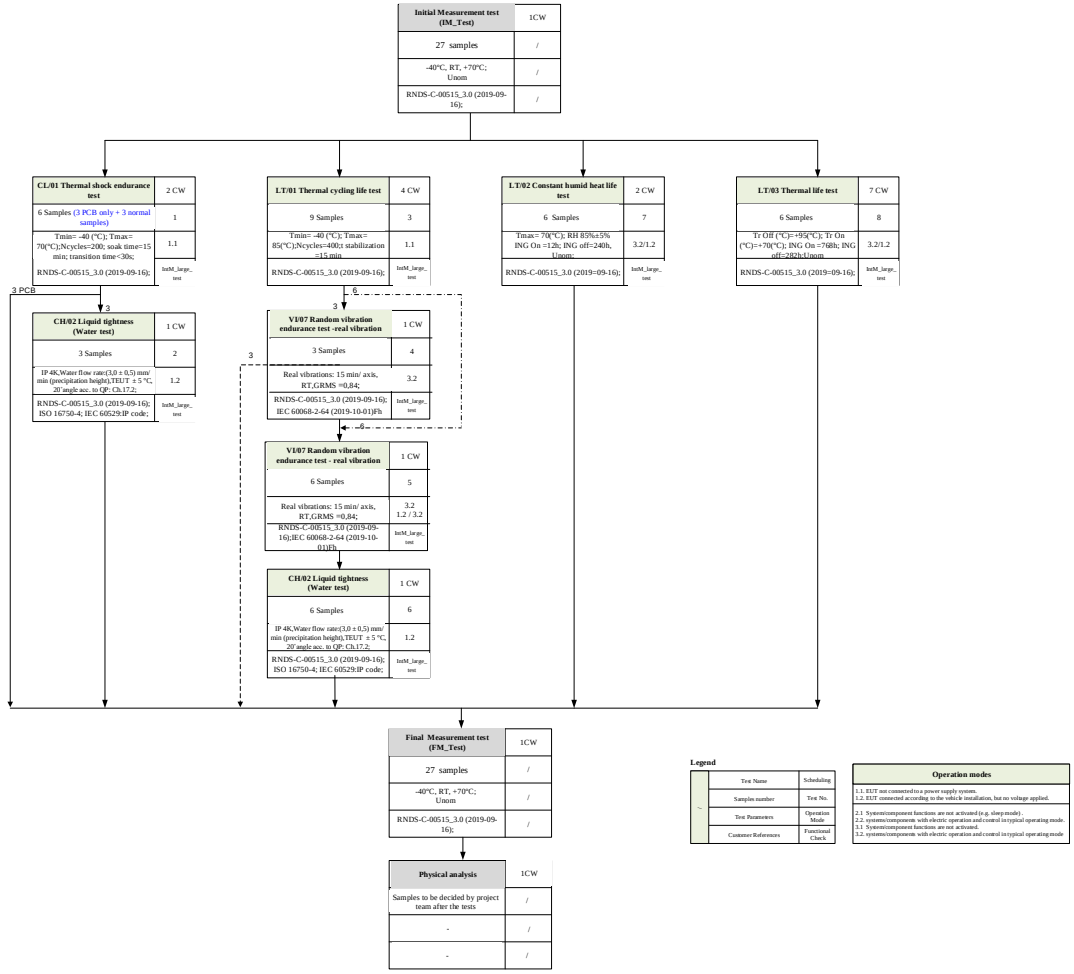
Date:	14.03.2022
Version:	V02(Draft)

FACEazy PCU – DV/PV tests Flow-Chart

ENDURANCE TESTS



Project: REN_EZ1_23_IVS_PCU

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Test flow:	Test Flow for DV/PV
Editor:	Madalina Davidescu
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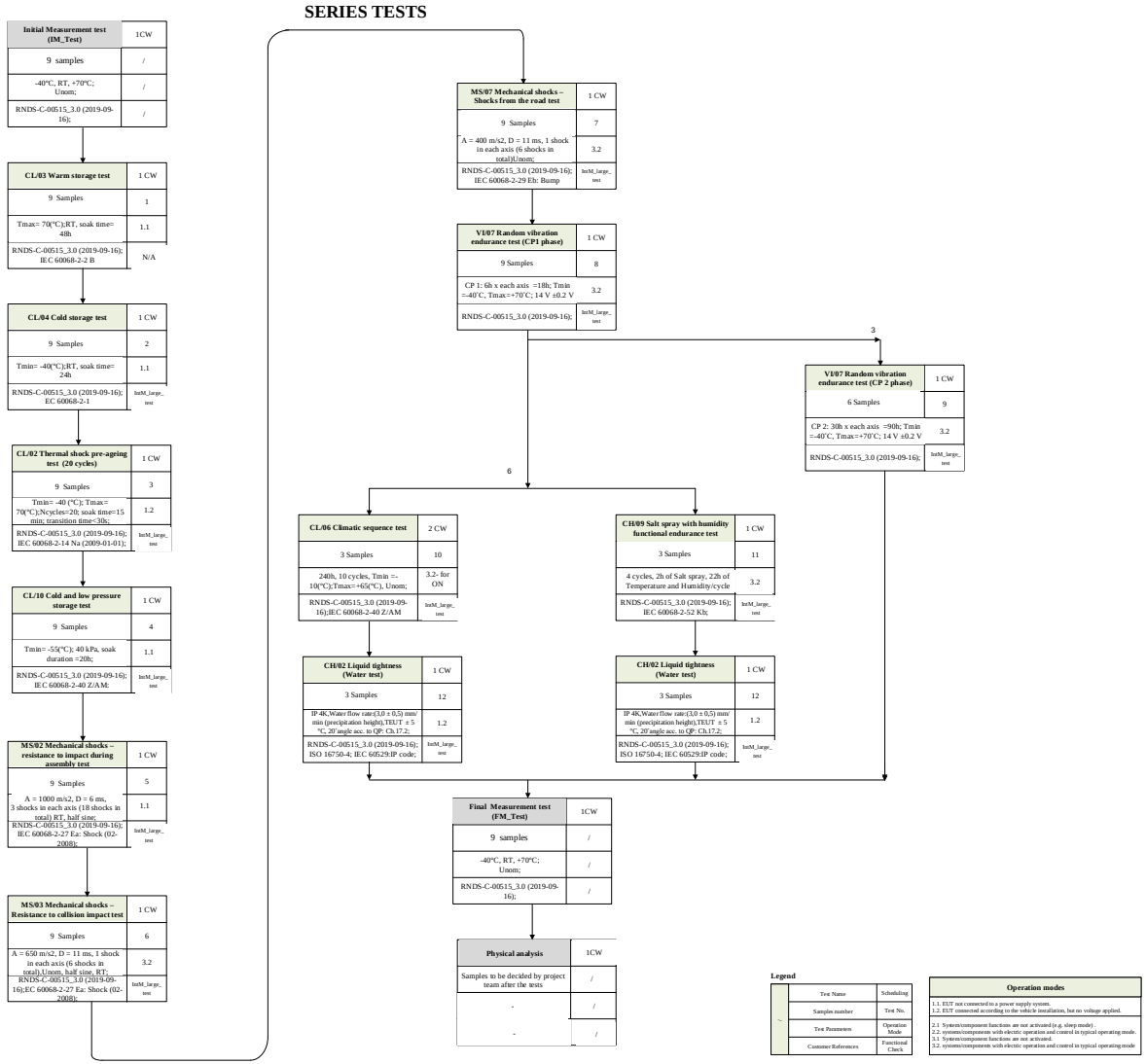
Date:	14.03.2022
Version:	V02(Draft)

FACEazy PCU – DV/PV tests Flow-Chart



Designed by : Madalina Davidescu	Date: 17.05.2022	Depart: AN CE SYS EU1 IAS GD6	Sign:
Continental	Document name: Qualification Program	Project: REN_EZ1_23_IVS_PCU	
	Document : QP_ENV_REN_EZ1_23_IVS_PCU_ALL_0048_V1.1 (17.05.2022)		Pages:32
Continental Iasi (AN) 2022			

13.2 Test Case activation

Proposal			**TC0**	**TC 1**	**TC 2**
TEST_CASE_TIME [min]			**60**	**60**	**60**
Cyclic Monitoring [sec]			**30**	**30**	**30**
Activation	**Parameter**	**Unit**	SetValue	SetValue	SetValue
A53_CPU_0	LOAD	%	75	50	25
A53_CPU_1	LOAD	%	75	50	25
A53_CPU_2	LOAD	%	75	50	25
A53_CPU_3	LOAD	%	75	50	25
M7_CPU_0	LOAD	%	75	50	25
RAM	LOAD	MB	75	50	50
eMMC	LOAD	MB	10	10	10
CAN00_V1	BUSLOAD	%	75	50	25
CAN02_EXT	BUSLOAD	%	75	50	25
CAN04_OBD	BUSLOAD	%	75	50	25
OBD_Wakeup	State	ON/OFF	ON	ON	ON
ETH01_OBD	BUSLOAD	MBps	75	50	25
ETH_Loop	BUSLOAD	MBps	75	50	25
Test List	**Parameter**	**Unit**	Limits	Limits	Limits
ITM_CPU_Sensor_0	Temperature	°C	-43|90	-43|90	-43|90
ITM_CPU_Sensor_1	Temperature	°C	-43|90	-43|90	-43|90

ITM_CPU_Sensor_2	Temperature	°C	-43|90	-43|90	-43|90
ITM_PCB_Thermistor	Temperature	°C	-43|90	-43|90	-43|90
ITM_PMIC_Temperature	Temperature	°C	-43|90	-43|90	-43|90
ICPULM_A53_CPU_0	CPU LOAD	%	70|100	40|60	15|40
ICPULM_A53_CPU_1	CPU LOAD	%	70|100	40|60	15|40
ICPULM_A53_CPU_2	CPU LOAD	%	70|100	40|60	15|40
ICPULM_A53_CPU_3	CPU LOAD	%	70|100	40|60	15|40
ICPULM_M7_CPU_0	CPU LOAD	%	70|100	40|60	15|40
IMEMLM_RAM_Free	Memory LOAD	MB	TBD	TBD	TBD
IMEMLM_eMMC_Free	Memory LOAD	MB	TBD	TBD	TBD
IVM_AI_GWP2PMIC_AMUX	Internal_Voltage	Voltage	0|1.8	0|1.8	0|1.8
IVM_AI_GWP_VDD_0V9_ETH	Internal_Voltage	Voltage	0.8|1	0.8|1	0.8|1
IVM_AI_GWP_TEMP	Internal_Voltage	Voltage	0.2|0.9	0.2|0.9	0.2|0.9
IVM_AI_GWP_VDD_1V8_ETH	Internal_Voltage	Voltage	1.7|1.9	1.7|1.9	1.7|1.9
IVM_AI_GWP_VDD_1V0_ETH_PHY	Internal_Voltage	Voltage	0.8|1.1	0.8|1.1	0.8|1.1
IVM_AI_GWP_VDD_3V3_ETH	Internal_Voltage	Voltage	3.2|3.4	3.2|3.4	3.2|3.4
IETHLSM_SW0_P00	ETH Link Status	Decimal	1	1	1
IETHLSM_SW0_P01	ETH Link Status	Decimal	1	1	1
IETHLSM_SW0_P02	ETH Link Status	Decimal	1	1	1
IETHLSM_SW0_P03	ETH Link Status	Decimal	1	1	1
IETHLSM_SW0_P04_ETH03	ETH Link Status	Decimal	1	1	1
IETHLSM_SW0_P05_ETH02	ETH Link Status	Decimal	1	1	1
IETHLSM_SW0_P06	ETH Link Status	Decimal	1	1	1
IETHLSM_SW0_P07_ETH04	ETH Link Status	Decimal	1	1	1
IETHLSM_SW0_P12	ETH Link Status	Decimal	1	1	1
IETHLSM_SW0_P13	ETH Link Status	Decimal	1	1	1

IETHSQIM_SW0_P00	ETH SQI	Decimal	TBD	TBD	TBD
IETHSQIM_SW0_P01	ETH SQI	Decimal	TBD	TBD	TBD
IETHSQIM_SW0_P02	ETH SQI	Decimal	TBD	TBD	TBD
IETHSQIM_SW0_P03	ETH SQI	Decimal	TBD	TBD	TBD
IETHSQIM_SW0_P04_ETH03	ETH SQI	Decimal	TBD	TBD	TBD
IETHSQIM_SW0_P05_ETH02	ETH SQI	Decimal	TBD	TBD	TBD
IETHSQIM_SW0_P06	ETH SQI	Decimal	TBD	TBD	TBD
IETHSQIM_SW0_P07_ETH04	ETH SQI	Decimal	TBD	TBD	TBD
IETHSQIM_SW0_P12	ETH SQI	Decimal	TBD	TBD	TBD
IETHSQIM_SW0_P13	ETH SQI	Decimal	TBD	TBD	TBD
IETHLLCM_SW0_P00	ETH Link Loss Counter	Decimal	1	1	1
IETHLFCM_SW0_P00	ETH Link Failure Counter	Decimal	1	1	1
IETHLLCM_SW0_P01	ETH Link Loss Counter	Decimal	1	1	1
IETHLFCM_SW0_P01	ETH Link Failure Counter	Decimal	1	1	1
IETHLLCM_SW0_P02	ETH Link Loss Counter	Decimal	1	1	1
IETHLFCM_SW0_P02	ETH Link Failure Counter	Decimal	1	1	1
IETHLLCM_SW0_P03	ETH Link Loss Counter	Decimal	1	1	1
IETHLFCM_SW0_P03	ETH Link Failure Counter	Decimal	1	1	1
IETHLLCM_SW0_P04_ETH03	ETH Link Loss Counter	Decimal	1	1	1
IETHLFCM_SW0_P04_ETH03	ETH Link Failure Counter	Decimal	1	1	1
IETHLLCM_SW0_P05_ETH02	ETH Link Loss Counter	Decimal	1	1	1
IETHLFCM_SW0_P05_ETH02	ETH Link Failure Counter	Decimal	1	1	1
IETHLLCM_SW0_P06	ETH Link Loss Counter	Decimal	1	1	1
IETHLFCM_SW0_P06	ETH Link Failure Counter	Decimal	1	1	1
IETHLLCM_SW0_P07_ETH04	ETH Link Loss Counter	Decimal	1	1	1
IETHLFCM_SW0_P07_ETH04	ETH Link Failure Counter	Decimal	1	1	1

IETHLLCM_SW0_P12	ETH Link Loss Counter	Decimal	1	1	1
IETHLFCM_SW0_P12	ETH Link Failure Counter	Decimal	1	1	1
IETHLLCM_SW0_P13	ETH Link Loss Counter	Decimal	1	1	1
IETHLFCM_SW0_P13	ETH Link Failure Counter	Decimal	1	1	1
IVM_PMIC_GND	Internal_Voltage	Voltage	0|0.2	0|0.2	0|0.2
IVM_PMIC_VDDIO	Internal_Voltage	Voltage	3.1|3.4	3.1|3.4	3.1|3.4
IVM_PMIC_Bandgap_Main	Internal_Voltage	Voltage	TBD	TBD	TBD
IVM_PMIC_Bandgap_FS	Internal_Voltage	Voltage	TBD	TBD	TBD
IVM_VDD_0V8_CORE_BUCK1	Internal_Voltage	Voltage	0.6|0.9	0.6|0.9	0.6|0.9
IVM_VDD_0V8_CORE_BUCK2	Internal_Voltage	Voltage	0.6|0.9	0.6|0.9	0.6|0.9
IVM_VDD_1V1_RAM_BUCK3	Internal_Voltage	Voltage	1.7|1.9	1.7|1.9	1.7|1.9
IVM_VDD_3V3_CONST_VPRE	Internal_Voltage	Voltage	3.1|3.4	3.1|3.4	3.1|3.4
IVM_VDD_5V_BOOST	Internal_Voltage	Voltage	4.8|5.1	4.8|5.1	4.8|5.1
IVM_VDD_1V8_GWP_LDO1	Internal_Voltage	Voltage	1.7|1.9	1.7|1.9	1.7|1.9
IVM_VDD_1V8_RAM_LDO2	Internal_Voltage	Voltage	1.7|1.9	1.7|1.9	1.7|1.9
IVM_PMIC_BOS	Internal_Voltage	Voltage	4.8|5.1	4.8|5.1	4.8|5.1
IVM_Supply_Voltage_VSUP	Internal_Voltage	Voltage	TBD	TBD	TBD
IVM_PMIC_PWRON1	Internal_Voltage	Voltage	TBD	TBD	TBD
IVM_PMIC_PWRON2	Internal_Voltage	Voltage	TBD	TBD	TBD
IVM_VDD_0V8_STB_HVLDO	Internal_Voltage	Voltage	0.6|0.9	0.6|0.9	0.6|0.9
IVM_VDD_3V3_GWP_LDO3	Internal_Voltage	Voltage	3.1|3.4	3.1|3.4	3.1|3.4
ECANBLM_CAN00_V1	CAN BUSLOAD	%	60|80	40|60	15|40
ECANBLM_CAN02_EXT	CAN BUSLOAD	%	60|80	40|60	15|40
ECANBLM_CAN04_OBD	CAN BUSLOAD	%	60|80	40|60	15|40
ECANDRM_CAN00_V1	CAN StD_DataRate	Decimal	TBD	TBD	TBD
ECANDRM_CAN02_EXT	CAN StD_DataRate	Decimal	TBD	TBD	TBD

ECANDRM_CAN04_OBD	CAN StD_DataRate	Decimal	TBD	TBD	TBD
ECANEFRM_CAN00_V1	ETH ErrorFrameRate/ErrorFrames	Decimal	TBD	TBD	TBD
ECANEFRM_CAN02_EXT	ETH ErrorFrameRate/ErrorFrames	Decimal	TBD	TBD	TBD
ECANEFRM_CAN04_OBD	ETH ErrorFrameRate/ErrorFrames	Decimal	TBD	TBD	TBD
EETHLSM_ETH01_OBD	ETH Link_Speed	Mbit/s	70|100	40|60	15|40
EETHLSM_Loop	ETH Link_Speed	Mbit/s	70|100	40|60	15|40
ECANFCM_CAN00_V1	CAN BUSLOAD	%	60|80	40|60	15|40
ECANFCM_CAN02_EXT	CAN BUSLOAD	%	60|80	40|60	15|40
ECANFCM_CAN04_OBD	CAN BUSLOAD	%	60|80	40|60	15|40
Check DUT External Feedbacks			Limits	Limits	Limits
EVM_KL30_0_Supply	External_Voltage	Voltage	TBD	TBD	TBD
EIM_KL30_0_Supply	External_Current	Current_Cunsomption	TBD	TBD	TBD

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14 VIBRATIONS TESTS-VI

14.1 VI/01 : RESONANCE INVESTIGATION. RESONANCE-POINT DETECTING TEST

Test purpose:

The resonance point detection test is carried out in order to detect intrinsic resonance frequency of electronic equipments for practicing endurance vibration tests. The purpose is to have knowledge of the resonance frequencies inside the ECU.

Applicable standards:

RNDS-C-00515 "BASIC PHYSICOCHEMICAL ENVIRONMENTAL SPECIFICATIONS OF ELECTRONIC PARTS Rev 3.0 (2019-09-16);

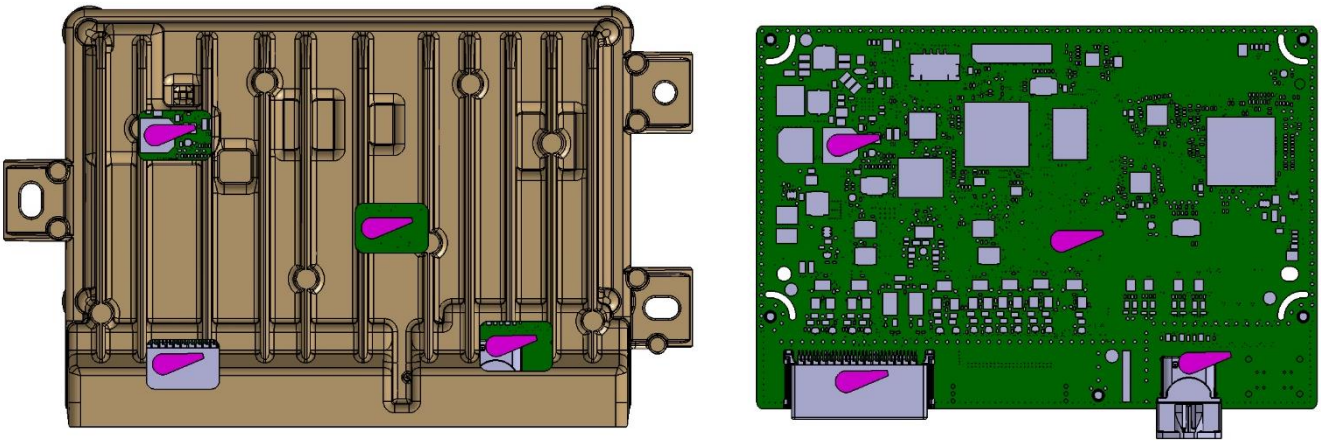
Deviation:

Operating mode 1.2. instead of 3.2. Test for characterization only.

Test Parameters:

Vibration Frequency range [Hz]	10Hz to 1 000Hz
Linear sweeping	at 1 Hz/s
Sweeping cycle	33 min
Vibration acceleration	9.8 m/s² peak
Maximum Amplitude	20 mm
Test Temperature	RT (Room temperature)
Number of cycle	2 (1 back and forth) (10Hz-1000Hz and 1000Hz-10Hz)
Operating Mode	1.2
EUT Test Position	On the axis
Operating class & gravity level	A/0
Number of EUT	1 (Refer to DV/PV flowchart)

Resonance measurement points:



4 Sensors
Sensor 1 = Connector 32way
Sensor 2 = Connector Ethernet
Sensor 3 = PCB (middle)
Sensor 4 = Elko

Initial Evaluation of Test:

Before starting the environment test the EUTs shall pass the preceding initial measurement test IM_test (as indicated by the test flow) and may not show any mechanical damage on the visual inspection.

Test Procedure:

The accelerometers must be placed on middle of PCB, on micro and on sensitive components regarding vibration (big components such as electrolytic capacitors, relays..). Accelerometers location will be confirmed with Q-Lab during DV Test.

A. Place the EUT on a vibration machine using fixture similar to in vehicle mounting position.
B. Perform the test at effective acceleration values for finding resonance frequencies on the points indicated in the picture above (internal connectors, relays and other electromechanical devices);
C. Vibrate the test samples for a period of 1 minute while sweeping through the frequency range of 10-1000 Hz at an acceleration of 9.8 m/s^2.
D. Detect the resonance frequencies by increasing and decreasing the frequency at a constant rate within the vibration range shown in the table above.
E. Record and document the resonance frequencies for the 3 different axes.

Acceptance Criteria:

The EUTs have passed the environmental test:
- if no damage or anomalies are found on visual inspection following the test.

A documentation of all tests is necessary, especially in case of mechanical damages such as deformations or cracks are detected (a picture to see where the sensors have been located, and the curves of these sensors to detect resonance frequency).

Validation report:

The following information must be given:
- A mounting interface drawing, including harness fixture(s);
- A drawing including expected measurement points;
- A picture to see where the sensors have been located,
- The curves of these sensors to detect resonance frequency.

14.2 VI/05 : RESONANCE-POINT 1h OSCILLATION TEST

Test purpose:

Confirm the vibration resistance of electronic equipment (mainly for cases and brackets). According to the applicable vehicle type, the vibration acceleration shall be selected from the following tables. For the resonance-point 1h oscillation test, the EUT which have been subjected to the resonance detecting test VI/01 shall be used.

Applicable standards:

RNDS-C-00515 "BASIC PHYSICOCHEMICAL ENVIRONMENTAL SPECIFICATIONS OF ELECTRONIC PARTS Rev 3.0 (2019-09-16);
IEC 60068-2-6 Fc: Sinusoidal vibrations (2007-12-01);

Deviation:

Use different parts for testing. VI/01 parts can not be used for VI/05 due to PCB accelerometer destructive placement.

Test Parameters:

Vibration Frequency range [Hz]	At each resonance frequency found
Vibration Acceleration	29,43 m/s^2
Duration	1 hour per axis (vertical, lateral, longitudinal)
EUT axis to test	X, Y, Z
Test temperature	RT (Room temperature)
Nominal Power Supply (U_{nom})	14 V ±0.2 V
Operating Mode	3.2
EUT Test Position	On the axis
Operating class & gravity level	A/0
Number of EUTs	3 (Refer to DV/PV flowchart)

***Note:** The test will be performed only if the resonance point was recorded in the previous test VI / 01.

Initial Evaluation of Test:

Before starting the environment test the EUTs shall pass the preceding initial measurement test IM_test (as indicated by the test flow) and may not show any mechanical damage on the visual inspection.

Test Procedure:

A cable harness true to the original cable harness in the vehicle has to be used (same cable width like in the vehicle; no additional cables in the harness are allowed).

The mechanical support of the cable harness has to be on the vibration fixture.Vibration control is on the vibration fixture. Demonstrative acoustical behavior (noise, rattling) has to be documented.

A. Place the EUT on a vibration machine using fixture similar to in vehicle mounting position.

B. The cable harness has to be reinforced (fixed) in a distance of < 50 cm to the connector.
C. To measure the applied vibration acceleration at shaking table or fixing jig.
D. Perform testing at each resonance frequency determined during VI/01 resonance-point detecting test according to the temperature and electrical operation profile above.
E. At the end of test cycle for this axis, repeat steps A and C for the remaining two axes.

Acceptance Criteria:

The EUTs have passed the environmental test:

- if no damage or anomalies are found on visual inspection following the test.
- If no any permanent deformation of the fasteners, mechanical damage such as deformation or cracks (elements, circuit board (including soldered areas), connectors and aluminum parts).

A documentation of all tests is necessary, especially in case of mechanical damages such as deformations or cracks are detected.

14.3 VI/07 : RANDOM VIBRATION ENDURANCE TEST

Test purpose:

Evaluate the function and strength of electronic equipment when vibration is applied by simulating vehicle vibration conditions, as well as to check for deterioration or predict failure in components.

Applicable standards:

RNDS-C-00515 “BASIC PHYSICOCHEMICAL ENVIRONMENTAL SPECIFICATIONS OF ELECTRONIC PARTS Rev 3.0 (2019-09-16);

IEC 60068-2-64 (2019-10-01)Fh : Vibration, broad-band random (digital control) and guidance

Test Parameters:

Vibration Frequency range [Hz]	10Hz to 1000Hz
EUT mounting location code	II (inside the instrument panel)
Duration	CP1 = 6 hours per axis CP2 = 30 hours per axis
EUT axis to test	X, Y, Z
Test temperature	RT (Room temperature)
Maximum Temperature (Tmax)	70°C
Minimum Temperature (Tmin)	-40°C
Nominal Power Supply (Unom)	14 V ±0.2 V
Operating Mode	3.2
EUT Test Position	On the axis
Operating class & gravity level	A´ and A at confirmation points 1 and 2 / 0
Number of EUTs	Refer to DV/PV flowchart

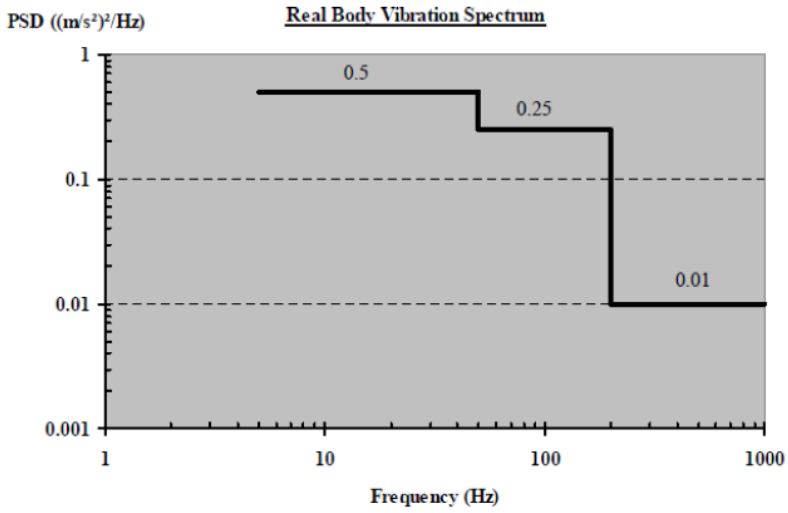
***Note: VI/07 test has to be performed without brackets (ECU directly on vibrating facility).

Initial Evaluation of Test:

Before starting the environment test the EUTs shall pass the preceding initial measurement test IM_test (as indicated by the test flow) and may not show any mechanical damage on the visual inspection.

14.3.1 TEST WITH REAL VIBRATIONS

Vibration profile	Real
Stress duration per axis/EUT	15 min
EUT axis to test	X, Y, Z
Test temperature	RT (Room temperature)
Nominal Power Supply (U_{nom})	14 V ±0.2 V
Operating Mode	3.2
EUT Test Position	On the axis
Operating class & gravity level	A /0
Number of EUTs	Refer to DV/PV flowchart

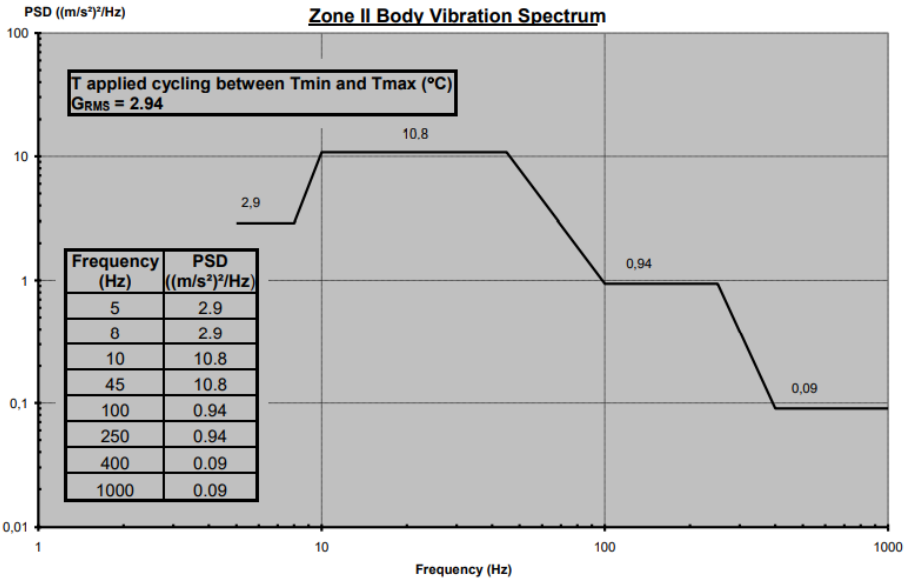


Frequency (Hz)	PSD ((m/s²)²/Hz)
5	0.5
50	0.25
200	0.01
1000	0.01

G_{RMS} = 0.84

14.3.2 TEST WITH ACCELERATED VIBRATIONS

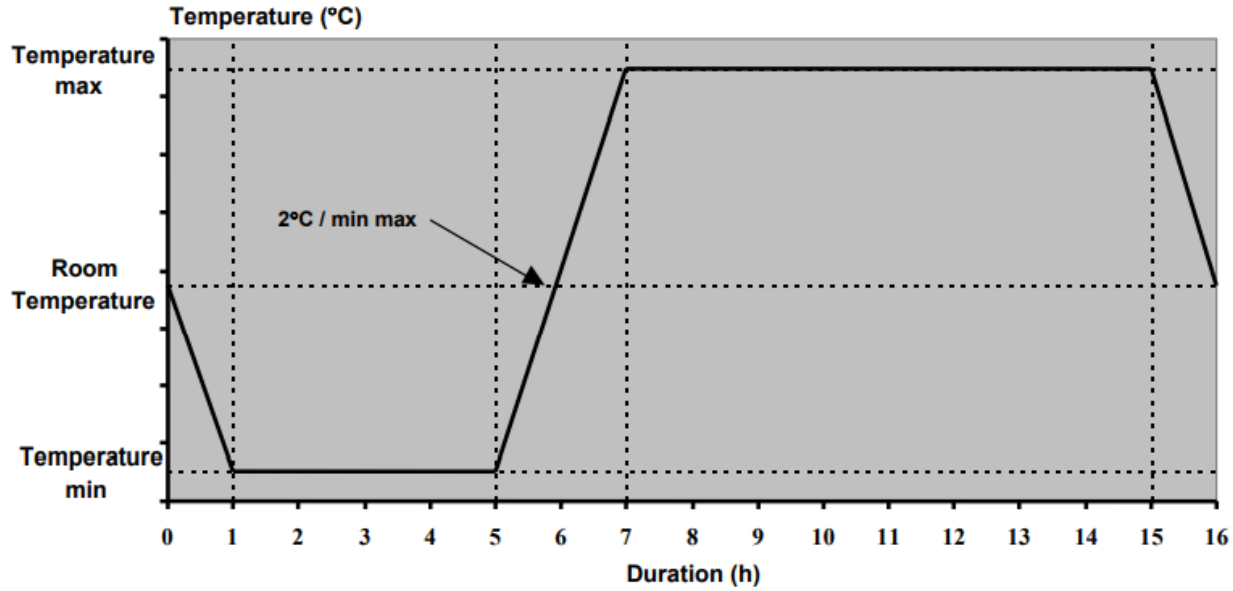
Vibration profile	Accelerated
Warranted mileage	220 000 km
Stress duration per axis/EUT	36h = CP1+CP2 (CP1 = 6h & CP2 = 30h)
EUT axis to test	X, Y, Z
Maximum Temperature (Tmax)	70°C
Minimum Temperature (Tmin)	-40°C
Rate of air temperature change	2°C/min max
Nominal Power Supply (U_{nom})	14 V ±0.2 V
Operating Mode	1.2 3.2 at confirmation points
EUT Test Position	On the axis
Operating class & gravity level	Class A' Class A at confirmation points/ 0
Number of EUTs	Refer to DV/PV flowchart



Frequency (Hz)	PSD ((m/s²)²/Hz)
5	2.9
8	2.9
10	10.8
45	10.8
100	0.94
250	0.94
400	0.09
1000	0.09

Thermal profile for the random vibration endurance

This profile has to be repeated until end of vibration for each axes.



Steps	Customer specification timing (h)	CP1 timing (h)	CP2 timing (h)
RT -> Tmin	**1**	**1**	**1**
Tmin	**4**	**40 min**	**8**
Tmin -> Tmax	**2**	**2**	**2**
Tmax	**8**	**80 min**	**18**
Tmax -> RT	**1**	**1**	**1**
TOTAL	**16**	**6**	**30**

Confirmation point CP1 : after 6 h on each axis.

- Parts must be fully functional and with no mechanical damage.
- The confirmation point CP1 validates the reliability of the housing.

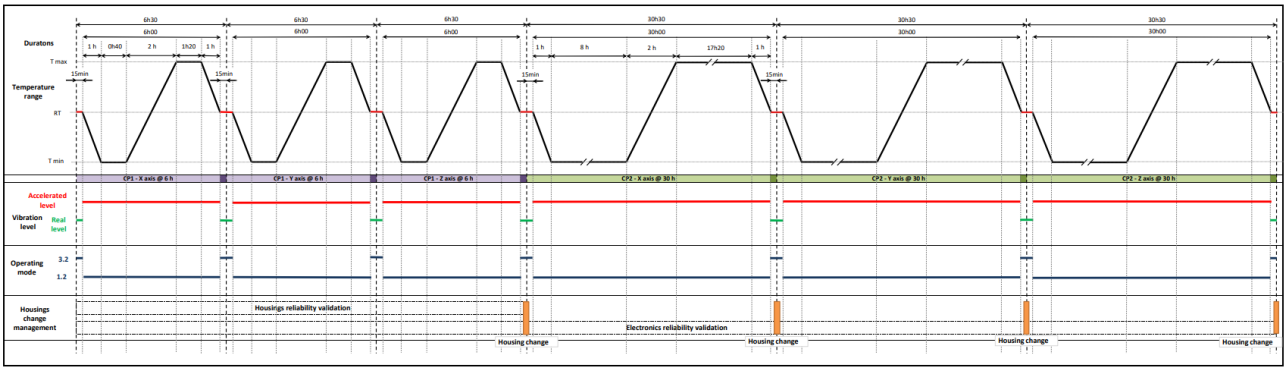
Confirmation point CP2 : after 30 h on each axis.

- Parts must be fully functional, no mechanical damage on electronic components, connectors, circuit board.
- Deformation or cracks may appear on mechanical plastic housing.
- The confirmation point CP2 validates the reliability of the electronics.
- As a consequence, after CP1, plastic housing must be changed for new ones before continuing till CP2.

As a summary :

On all axis :
• phase #1 : 15min O.P. : 3.2
• phase #2 CP1 6h O.P. : 1.2
• phase 3 : 15min O.P. : 3.2

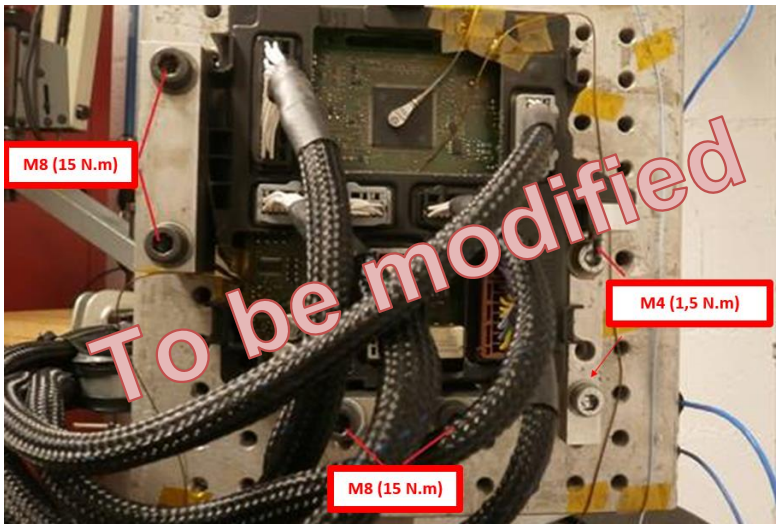
On all axis :
• phase #1 : 15min O.P. : 3.2
• phase #2 CP2 30h O.P. : 1.2
• phase 3 : 15min O.P. : 3.2



Test Procedure:

A cable harness true to the original cable harness in the vehicle has to be used (same cable width like in the vehicle; no additional cables in the harness are allowed). The mechanical support of the cable harness has to be on the vibration fixture. Vibration control is on the vibration fixture. Demonstrative acoustical behavior (noise, rattling) has to be documented.

A. Place the EUT on a vibration fixture and fasten complete assembly on vibration table with screws.
B. Apply nominal torque to screws. No bracket used.
C. Put the mechanical support of cable harnesses on the vibration fixture.
D. Fix cable harnesses in car mounting representative position.
E. Fix cable harnesses in a distance < 50 cm from the connector.
F. Select an acceleration sensor of a mass at least 20 times smaller than the mass of the EUT.
G. Operate the EUT electrically according to the temperature and electrical operation profile above.
H. Perform testing per conditions specified below
I. At the end of test cycle for this axis, repeat steps for the remaining two axes.



Acceptance Criteria:

The EUTs have passed the environmental test:

- The EUT shall be fully functional before and after the test and all parameters shall meet the specifications. Verification is done by means of a intermediate measurement test large, IntM_large_test as per Section 11.1.1.3.
- if no damage or anomalies are found on visual inspection following the test.
- If no any permanent deformation of the fasteners, mechanical damage such as deformation or cracks. No noise (buzzes, speaks or rattles).

A documentation of all tests is necessary, especially in case of mechanical damages such as deformations or cracks are detected.

Validation report:

The following information must be given:

- Real curve applied to ECU and PSD real RMs value;
- Shaker parameters (number of D.O.F. and peak factor.

15 MECHANICAL SHOCKS -MS

15.1 MS/01 : FREE FALL TEST

Test purpose:

Evaluation of the behavior of the equipment under test in the case of free fall before and after the manufacture of the car (mounting, transportation, maintenance, etc.).

Applicable standards:

RNDS-C-00515 "BASIC PHYSICOCHEMICAL ENVIRONMENTAL SPECIFICATIONS OF ELECTRONIC PARTS Rev 3.0 (2019-09-16);
ISO 16750-3: (2012-12-15);
IEC 60068-2-32 Ed: Free-fall;

Test Parameters:

Drop Height	1 m
Drop Directions,	See table below
Number of drops per EUT	Twice in each axis (in normal and reverse directions)
Impact Surface	Concrete ground
Test Temperature	RT (Room temperature)
Temperature Reference Point	Ambient temperature (chamber temperature)
EUT Test Position	See directions and numbers below
Operating Mode	1.1
Operating class & gravity level	A´/0
Number of samples	3 (Refer to DV/PV flowchart)

Drop Directions and Numbers: For more samples: must be clarified the drop directions with project team.

EUTs	**Drop directions**	
	1st drop	**2nd drop**
1st EUT	+X	-X
2nd EUT	+Y	-Y
3rd EUT	+Z	-Z

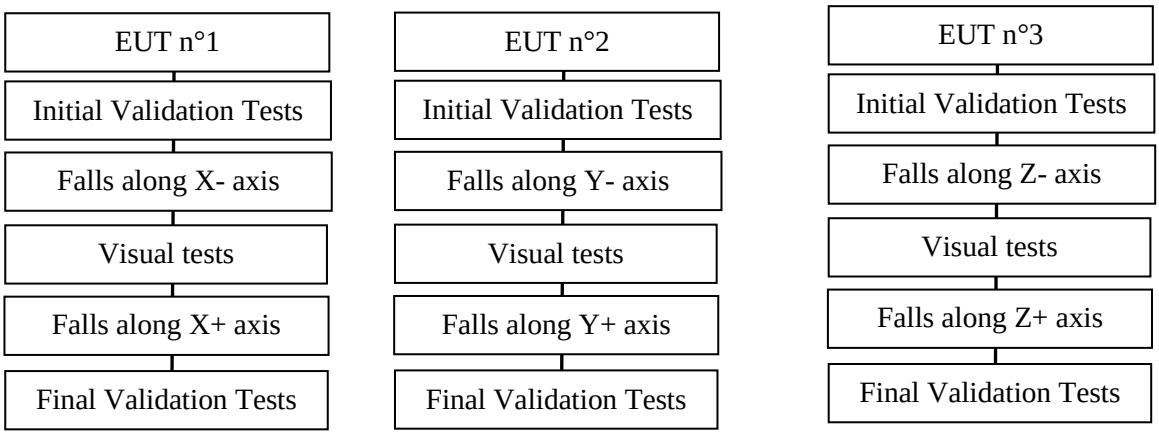
Initial Evaluation of Test:

Before starting the environment test the EUTs shall pass the preceding initial measurement test IM_test (as indicated by the test flow) and may not show any mechanical damage on the visual inspection.

Test Procedure:

A. The EUTs are to be dropped according the parameters given above;
B. Visually inspect the EUTs for any obvious damage visible to the naked eye. Any and all damage noted following each drop must be fully documented with pictures, clearly noting the axis in which the damage occurred (refer to the definition of axes section).

Sequence:



Acceptance Criteria:

The EUT shall be fully functional before and after the test and all parameters shall meet the specifications. Verification is done by means of a intermediate measurement test large, IntM_large_test as per Section 11.1.1.3.

There are two kinds of results for this test:

1. If the EUT is visibly damaged (it has to be easily obvious), then the test is considered as passed because we can considered that the EUT will be thrown away in this case.
2. If the ECU is not visibly damaged after the first drop or after both drops, functionnality is 100 % guaranteed and the test is considered as passed.
3. Confirm marking: “To throw away in case of free-fall” is written on housing of EUT.

Validation report:

If the EUT is visibly damaged, all incidents of damage shall be documented in the test report with pictures of external/internal aspect of the EUT.

15.2 MS/02 MECHANICAL SHOCKS STRENGTH TESTS- Resistance to impact during assembly

Test purpose:

Confirm the strength against shock from worker's handling in the plant and traffic accident. Mechanical shock occurring during assembly (shock from tightening by air pressurized tools.

Applicable standards:

RNDS-C-00515 "BASIC PHYSICOCHEMICAL ENVIRONMENTAL SPECIFICATIONS OF ELECTRONIC PARTS Rev 3.0 (2019-09-16);

IEC 60068-2-27 Test Ea and guidance: Shock (1-02-2008);

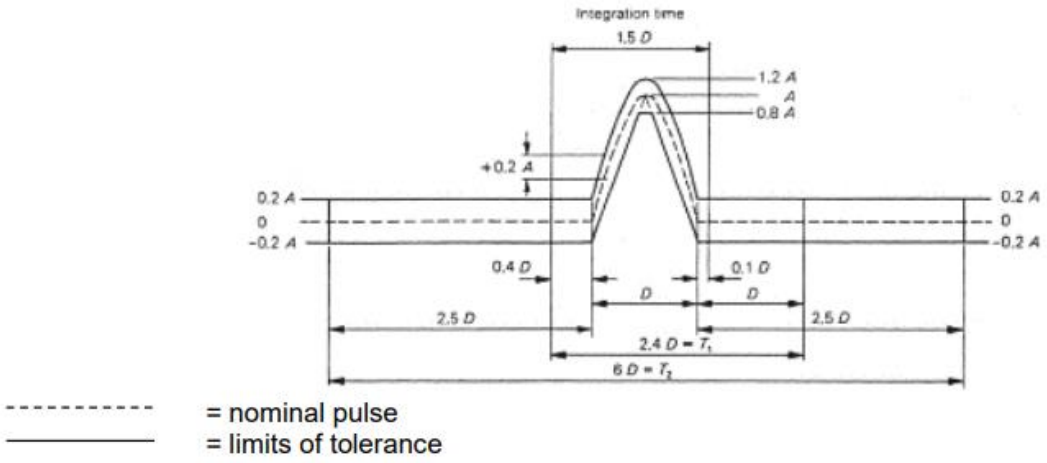
Test Parameters:

Number and direction of shock	See table below
Shock form (pulse shapes)	Half-sine
Peak acceleration of nominal pulse	1000 m/s²
Peak duration of nominal pulse	6 ms
Number of shocks per EUT	3 for each direction= 18 in total
Test Temperature	RT (Room temperature)
Temperature Reference Point	Ambient temperature (chamber temperature)
EUT Test Position	See directions and numbers below
Operating Mode	1.1
Operating class & gravity level	A´/0
Number of samples	6 (Refer to DV/PV flowchart)

Temperature and Number of Shocks per Direction:

Temperature	Mechanical Shocks Each Direction					
RT	**+X**	**-X**	**+Y**	**-Y**	**+Z**	**-Z**
	3	3	3	3	3	3

Half-sine wave test profile:



Legend:
D = duration of nominal pulse;
A = peak acceleration of nominal pulse;
T1 = minimum time during which the pulse shall be monitored for shocks produced using a conventional shock testing machine;
T2 = minimum time during which the pulse shall be monitored for shocks produced using a vibration generator;

Initial Evaluation of Test:

Before starting the environment test the EUTs shall pass the preceding initial measurement test IM_test (as indicated by the test flow) and may not show any mechanical damage on the visual inspection.

Test Procedure:

A cable harness true to the original cable harness in the vehicle has to be used (same cable width like in the vehicle); no additional cables in the harness are allowed.The mechanical support of the cable harness has to be on the vibration fixture.

Vibration/pulse control is on the vibration fixture.

Demonstrative acoustical behavior (noise, rattling) has to be documented.

A. The EUT shall be fixed on the shaker in a direction to generate the effect of acceleration in the same direction as it occurs in the vehicle use. Acceleration resulting from the shock in the test shall be in the same direction as the acceleration of the shock that occurs in the vehicle.
B. The cable harness has to be reinforced (fixed) in a distance of (15 ± 2) cm to the connector.
C. Apply a half-sine shock pulse (number of shocks, direction and test temperature as indicated in tables above).

Acceptance Criteria:

- The EUT shall be fully functional before and after the test and all parameters shall meet the specifications. Verification is done by means of a intermediate measurement test large, IntM_large_test as per Section 11.1.1.3.
- if no damage or anomalies are found on visual inspection following the test.

Validation report:

The following information must be given:

- Real curve applied to ECU.

15.3 MS/03 : MECHANICAL SHOCKS STRENGTH TEST - Resistance to collision impact at a reparable level

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Test purpose:

Confirm the strength against shock from worker's handling in the plant and traffic accident. Mechanical shock occurring during assembly (shock from tightening by air pressurized tools.

Applicable standards:

RNDS-C-00515 "BASIC PHYSICOCHEMICAL ENVIRONMENTAL SPECIFICATIONS OF ELECTRONIC PARTS Rev 3.0 (2019-09-16);

IEC 60068-2-27 Test Ea and guidance: Shock (1-02-2008);

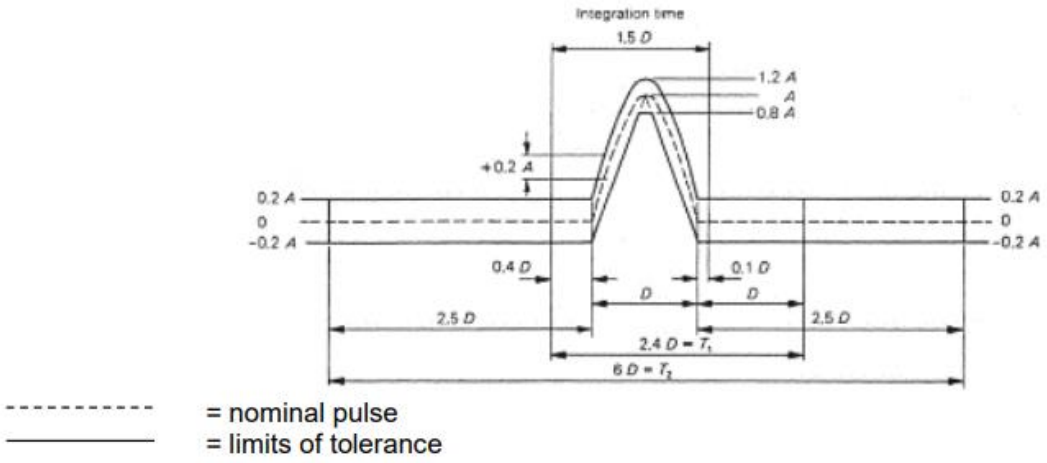
Test Parameters:

Number and direction of shock	See table below
Shock form (pulse shapes)	Half-sine
Peak acceleration of nominal pulse	650 m/s²
Peak duration of nominal pulse	11 ms
Number of shocks per EUT	1 for each direction= 6 in total
Test Temperature	RT (Room temperature)
Nominal Power Supply (U_{nom})	14 V ±0.2 V
Temperature Reference Point	Ambient temperature (chamber temperature)
EUT Test Position	See directions and numbers below
Operating Mode	3.2
Operating class & gravity level	A (ECUs which is expected to keep operating during impact)/0
Number of samples	6 (Refer to DV/PV flowchart)

Temperature and Number of Shocks per Direction:

Temperature	Mechanical Shocks Each Direction					
RT	+X	-X	+Y	-Y	+Z	-Z
	1	1	1	1	1	3

Half-sine wave test profile:



Legend:

D = duration of nominal pulse;
A = peak acceleration of nominal pulse;
T1 = minimum time during which the pulse shall be monitored for shocks produced using a conventional shock testing machine;
T2 = minimum time during which the pulse shall be monitored for shocks produced using a vibration generator;

Initial Evaluation of Test:

Before starting the environment test the EUTs shall pass the preceding initial measurement test IM_test (as indicated by the test flow) and may not show any mechanical damage on the visual inspection.

Test Procedure:

A cable harness true to the original cable harness in the vehicle has to be used (same cable width like in the vehicle); no additional cables in the harness are allowed.The mechanical support of the cable harness has to be on the vibration fixture.

Vibration/pulse control is on the vibration fixture.

Demonstrative acoustical behavior (noise, rattling) has to be documented.

D. The EUT shall be fixed on the shaker in a direction to generate the effect of acceleration in the same direction as it occurs in the vehicle use. Acceleration resulting from the shock in the test shall be in the same direction as the acceleration of the shock that occurs in the vehicle.
E. The cable harness has to be reinforced (fixed) in a distance of (15 ± 2) cm to the connector.
F. Apply a half-sine shock pulse (number of shocks, direction and test temperature as indicated in tables above).

Acceptance Criteria:

- The EUT shall be fully functional before and after the test and all parameters shall meet the specifications. Verification is done by means of a intermediate measurement test large, IntM_large_test as per Section 11.1.1.3.
- if no damage or anomalies are found on visual inspection following the test.

Validation report:

The following information must be given:

- Real curve applied to ECU.

15.4 MS/07 : MECHANICAL SHOCKS STRENGTH TEST - Shocks from the road.

Test purpose:

Confirm the resistance of electronic equipment to strong impact from the road during actual use, such as running over a curbstone without resulting in a traffic accident.

Applicable standards:

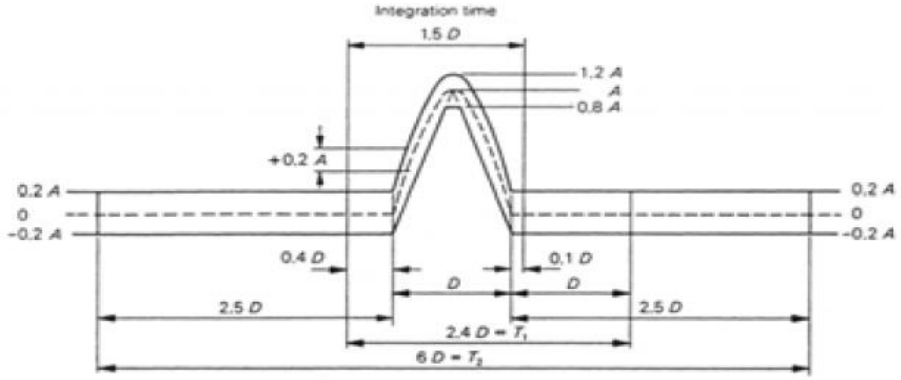
RNDS-C-00515 "BASIC PHYSICOCHEMICAL ENVIRONMENTAL SPECIFICATIONS OF ELECTRONIC PARTS Rev 3.0 (2019-09-16);

IEC 60068-2-29 Eb: Bump;

Test Parameters:

Number and direction of shock	See table below
Shock form (pulse shapes)	Half-sine
Peak acceleration of nominal pulse	4000 m/s²
Peak duration of nominal pulse	11 ms
Number of shocks per EUT	1 for each direction= 6 in total
Test Temperature	RT (Room temperature)
Nominal Power Supply (U_{nom})	14 V ±0.2 V
Temperature Reference Point	Ambient temperature (chamber temperature)
EUT Test Position	See directions and numbers below
Operating Mode	3.2
Operating class & gravity level	A /0
Number of samples	6 (Refer to DV/PV flowchart)

Half-sine wave test profile:



---------- = nominal pulse

———— = limits of tolerance

D = duration of nominal pulse

A = peak acceleration of nominal pulse

T_1 = minimum time during which the pulse shall be monitored for shocks produced using a conventional shock testing machine

T_2 = minimum time during which the pulse shall be monitored for shocks produced using a vibration generator

Initial Evaluation of Test:

Before starting the environment test the EUTs shall pass the preceding initial measurement test IM_test (as indicated by the test flow) and may not show any mechanical damage on the visual inspection.

Test Procedure:

A cable harness true to the original cable harness in the vehicle has to be used (same cable width like in the vehicle); no additional cables in the harness are allowed.The mechanical support of the cable harness has to be on the vibration fixture.

Vibration/pulse control is on the vibration fixture.

Demonstrative acoustical behavior (noise, rattling) has to be documented.

A. The EUT shall be fixed on the shaker in a direction to generate the effect of acceleration in the same direction as it occurs in the vehicle use. Acceleration resulting from the shock in the test shall be in the same direction as the acceleration of the shock that occurs in the vehicle.
B. The cable harness has to be reinforced (fixed) in a distance of (15 ± 2) cm to the connector.
C. Apply a half-sine shock pulse (number of shocks, direction and test temperature as indicated in tables above).

Acceptance Criteria:

- The EUT shall be fully functional before and after the test and all parameters shall meet the specifications. Verification is done by means of a intermediate measurement test large, IntM_large_test as per Section 11.1.1.3.
- if no damage or anomalies are found on visual inspection following the test.

Validation report:

The following information must be given:

- Real curve applied to ECU.

15.5 MS/10 : BRACKETS AND FASTENERS STRENGTH TEST

Test purpose:

Confirm the mechanical strength of the brackets and the fasteners of the ECU. This test specification is designed based on the Allianz requirement of the collision impact with low speed (16 km/h).

Applicable standards:

RNDS-C-00515 "BASIC PHYSICOCHEMICAL ENVIRONMENTAL SPECIFICATIONS OF ELECTRONIC PARTS Rev 3.0 (2019-09-16);

Test Parameters:

Test Duration	1 day
Force applying	equal to 10 times its weight with a minimum of 200 N
Direction to test	X-, X+, Y-, Y+, Z-, Z+
Number of applying force per EUT	1 for each direction= 6 in total
Test Temperature	RT (Room temperature)
Temperature Reference point	Ambient temperature (laboratory temperature)
Operating Mode	1.1
Operating class & gravity level	N/A /0
Number of samples	3 (Refer to DV/PV flowchart)

Figure 1: Directions of the force to apply:

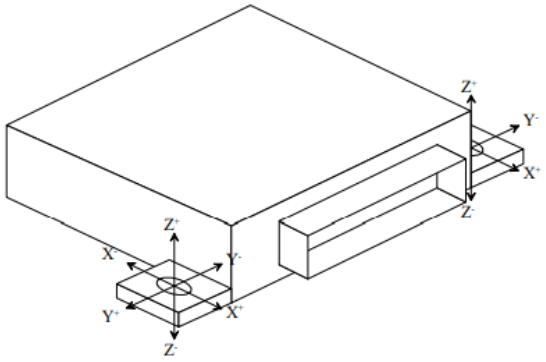
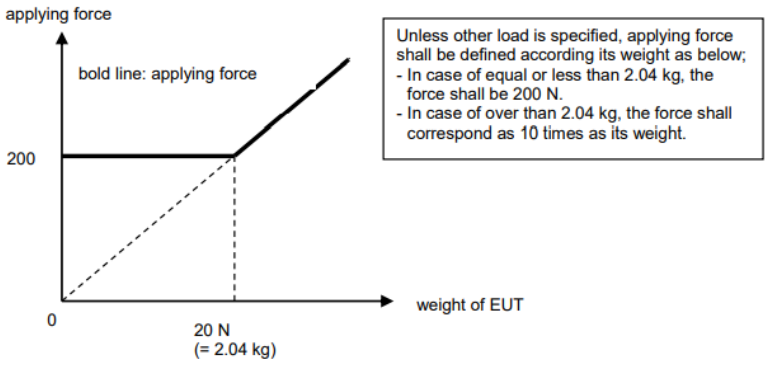


Figure 2: Applying force according to the weight of EUT:



Initial Evaluation of Test:

Before starting the environment test the EUTs shall pass the preceding initial measurement test IM_test (as indicated by the test flow) and may not show any mechanical damage on the visual inspection.

Test Procedure:

The tests consists in applying a force to the fastened equipment in the middle of every side of EUT, equal to 10 times its weight with minimum of 200 N along both directions of the X,Y and Z axes of the fastening plane (see picture above).

FACEASY PCU weight = 0,520 kg
10 times its weight = 5,200 kg (= 50,98 N)
Force to be applied = 200 N (minimum requested)

In addition, no force shall be applied on connector pins and vent holes.

Acceptance Criteria:

- The EUT shall be fully functional before and after the test and all parameters shall meet the specifications. Verification is done by means of a intermediate measurement test large, IntM_large_test as per Section 11.1.1.3.
- if no damage or anomalies are found on visual inspection following the test.

Validation report:

The following information must be given:
- A picture of external aspect of the ECU.

15.6 MS/11 : TERMINAL STRENGTH TEST (only connector)

Test purpose:

Confirm the soldering or press-fit strength and the mounting strength of connector terminals.

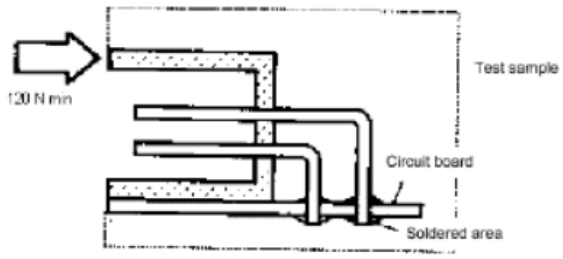
Applicable standards:

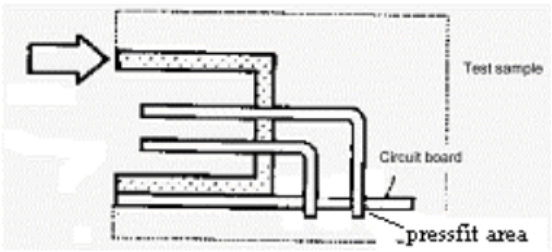
RNDS-C-00515 “BASIC PHYSICOCHEMICAL ENVIRONMENTAL SPECIFICATIONS OF ELECTRONIC PARTS Rev 3.0 (2019-09-16);

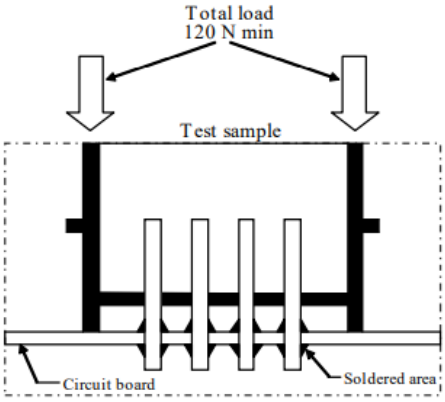
Test Parameters:

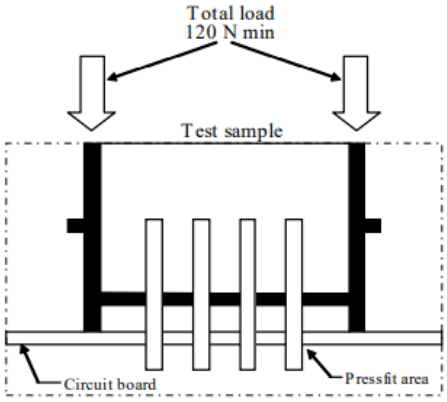
Test Duration	1 day
Force applying	10 times in each temperature
Force	120 N
Speed	20 mm/min
Stress duration	10 s at 120 N
Number of applying force per connector	10
Test temperature	(Tmin) -40°C
	RT
	(Tmax)+70°C
Operating Mode	1.1
Operating class & gravity level	A´ /0
Number of samples	3 (Refer to DV/PV flowchart)

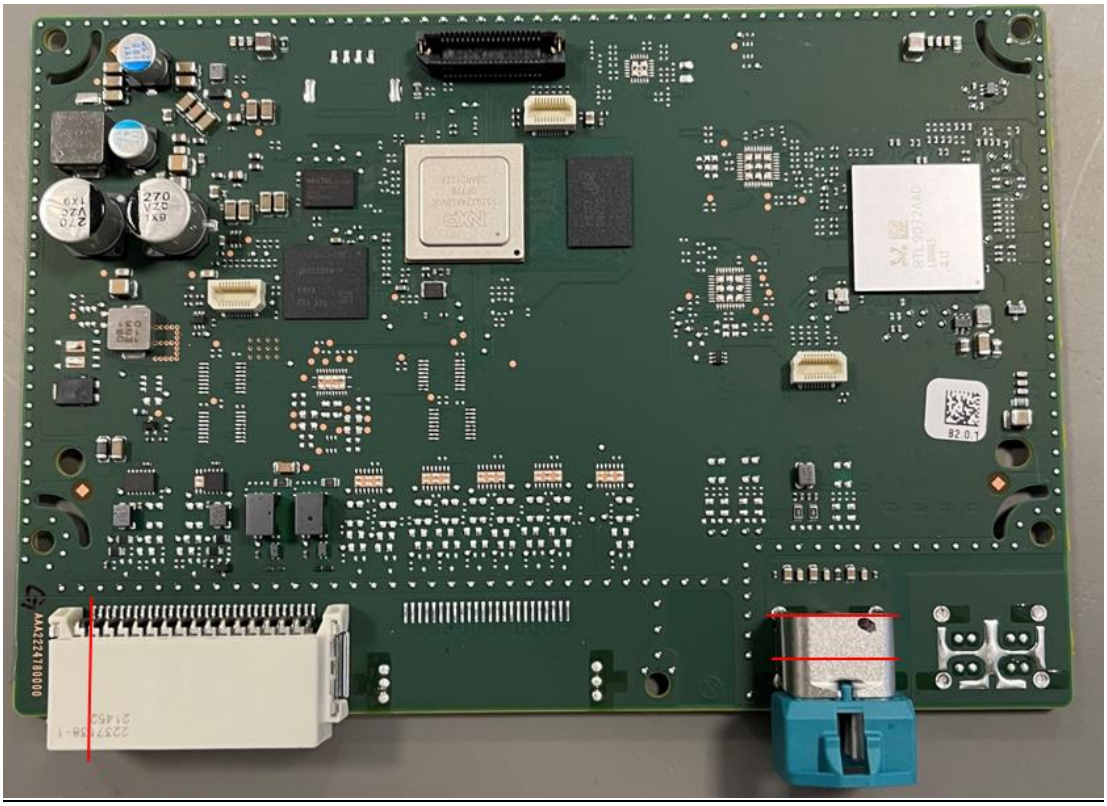
Figure 1: Load to apply for equipment with a direct insertion type connector











Initial Evaluation of Test:

Before starting the environment test the EUTs shall pass the preceding initial measurement test IM_test (as indicated by the test flow) and may not show any mechanical damage on the visual inspection.

Test Procedure:

1. Fasten EUT on traction table.
2. The EUT shall be supported by the whole area of the case to prevent distortion due to brackets.
3. Apply a load of 120 N min for 10 s to the entire area of the connector housing in the pressing direction of the terminal.Repeat the load 10 times.

Acceptance Criteria:

- The EUT shall be fully functional before and after the test and all parameters shall meet the specifications. Verification is done by means of a intermediate measurement test large, IntM_large_test as per Section 11.1.1.3.
- if no damage or anomalies are found on visual inspection following the test.

Validation report:

The following information must be given:

- Picture of internal aspect of solder joints of the ECU;
- Metallographic cross sections of solder joints to perform for soldered connector and also press fit connector;

16 CLIMATIC TESTS - CL

16.1 CL/00 : THERMAL INERTIA CHARACTERIZATION TEST

To be performed at the beginning of the DV CL/xx tests.
Not monitored test.

Test purpose:

In case of metallic and or thermal isolating casing, this test goal is to evaluate the temperature inertia between the PCB and the test environment and help calculate the delay for the thermal cycling test.

The aim of this test is:

- Evaluate the time for temperature on the PCB to reach the chamber temperature;
- Second, to have a sufficient confidence of the EUT thermal inertia in order to perform validations with confident at the first time. Really submit the PCB inside housing at a complete change of temperature between Tmax and Tmin.

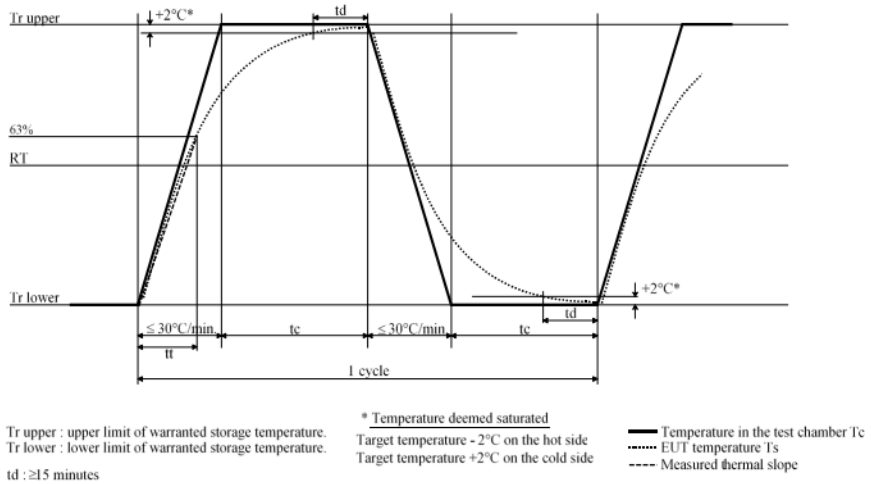
Applicable standards:

RNDS-C-00515 "BASIC PHYSICOCHEMICAL ENVIRONMENTAL SPECIFICATIONS OF ELECTRONIC PARTS Rev 3.0 (2019-09-16);

Test parameters:

Minimum storage temperature T_{rlower}	-40°C
Maximum storage temperature T_{rupper}	+70°C
Room temperature (RT)	23 ± 5 °C
Rate of Temperature Change (T_{Change})	+ / - 2 ºC
Temperature ransition rate	≤ 30°C/min
Temperature Reference Point	Ambient temperature (chamber temperature)
EUT Test Position	In-vehicle mounting orientation (See Ch 10.2)
Operating Mode	1.1
Operating class & gravity level	No/0
Number of samples	1 (Refer to DV/PV flowchart)

CL/00 Figure 1: Method of measuring the actual ECU temperature profile



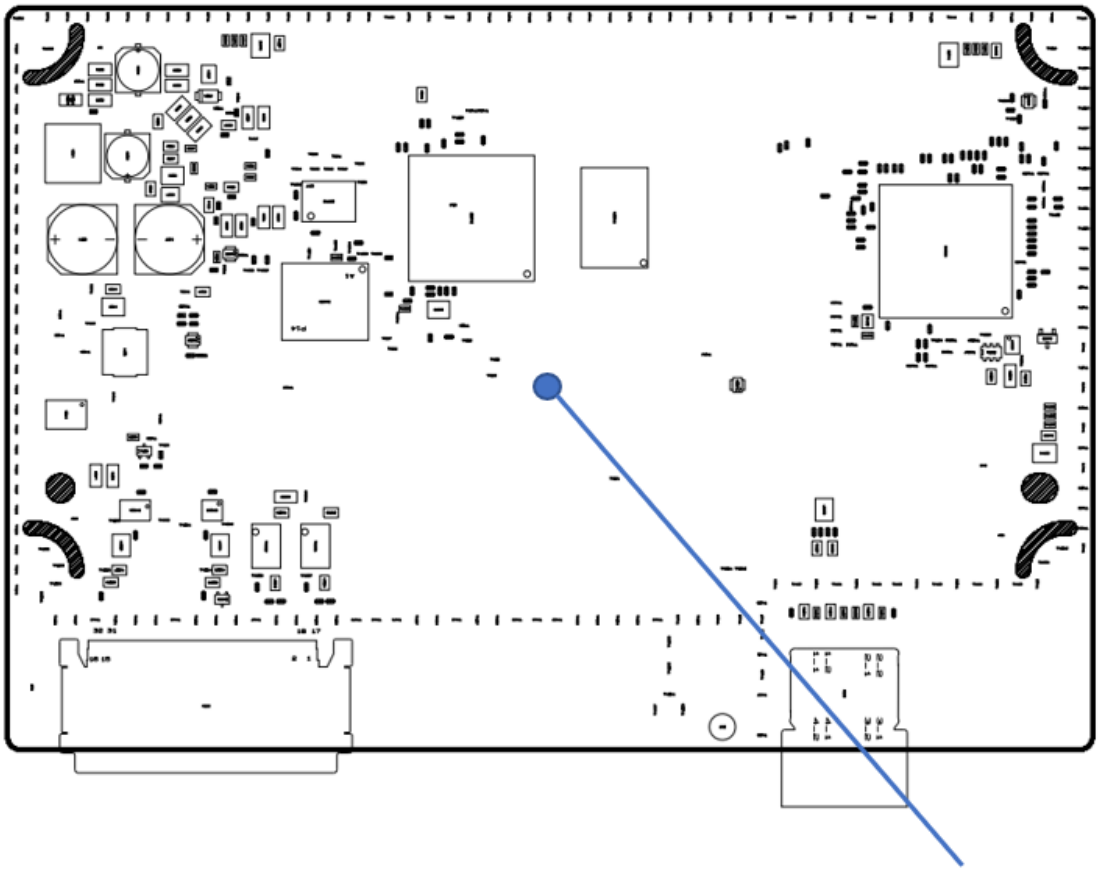
td =stabilized time;
tc = soak time

Initial Evaluation of Test:

Before starting the environment test the EUTs shall pass the preceding initial measurement test IM_test (as indicated by the test flow) and may not show any mechanical damage on the visual inspection

Check thermal sensor placed inside the climatic chamber and thermal sensor placed on the PCB inside the closed casing. If it is necessary to make a hole inside the housing, seal it with as silicone base paste or similar. Only one sample needed.

Thermocouples placement :



Test Procedure:

1. Begin the cycle with the cold phase and finish by the warm one otherwise condensation being able to disturb final measures (use the CL/00 Figure 1 cycle).
2. Unless otherwise specified in the EUT's test specification, choose:
   - Trlower = minimum storage temperature = -40°C
   - Trupper = maximum storage temperature = +70°C
3. The Chamber temperature (Tc) stabilization is reached when the temperature of the chamber is equal to the required temperature (i.e. Trupper or Trlower) +/- 2°C.

The soak time (tc) is the time where Trupper and Trlower are required inside the chamber.

4. The Sample temperature (Ts) stabilization is reached when the temperature of the sample is equal to the required temperature (i.e. Trupper or Trlower) +/- 2°C.

5. The stabilized time (td) is the time where Trupper and Trlower are reached inside the sample.
6. The soak time (tc) and the stabilized time (td) at Trupper and Trlower depend on the EUT thermal inertia and the chamber characteristics.

Acceptance Criteria:

The EUTs have passed the environmental test:
- if no damage or anomalies are found on visual inspection following the test.

A documentation of all tests is necessary, especially in case of mechanical damages such as deformations or cracks are detected:

- The measurement of the rise / fall time of the temperature inside the chamber.
- The measurement of the rise / fall time of the temperature inside the sample.
- Calculate the slope inside sample (response of the temperature inside the sample).
- Time delay between Tc and Ts at maximum and minimum temperature.

Comments:

This quick test carry out during the design of the product gives a very good view of the technological choices confidence and of the thermal inertia.

16.2 CL/01 : THERMAL SHOCKS ENDURANCE TEST

Test purpose:

The aim of this test is :

- First to mechanically age the EUT to rapidly find potential defects and solve them during development phase to validate technologies choices and compatibility (coefficient of expansion, mechanical strength, …)
- Second, to have a sufficient confidence level of the EUT strength in order to perform validations with success at the first time.
- Third, for lead free products, to investigate if there is any failures depending on lead-free soldering technology (e.g whiskers growth due to the CTE mismatch).

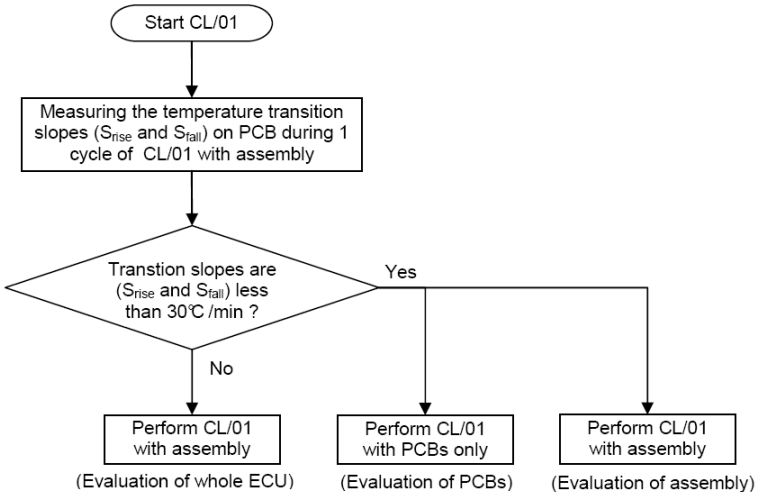
Applicable standards:

RNDS-C-00515 "BASIC PHYSICOCHEMICAL ENVIRONMENTAL SPECIFICATIONS OF ELECTRONIC PARTS Rev 3.0 (2019-09-16);
ISO 16750-4- (2010-04-15);
IEC 60068-2-14 Test Na: Change of temperature (2009-01);

Test parameters:

Total test duration	~13 days
Number of Test Cycle (N_{Cycle})	200
Minimum Chamber Temperature (T_{min}= T_A)	-40°C
Maximum Chamber Temperature (T_{max}= T_B)	+70°C
Holding Time (t_1) at T_{max}, T_{min}	1h after equilibrium time (+15min) => 90 min = > 45 min/ temperature
Transfer Time (t_2) between Chambers	<30s
EUT Test Position	Not relevant
Operating Mode	1.1
Operating class & gravity level	A´/0
Number of samples	6 Samples (3 PCB only + 3 normal samples) (Refer to DV/PV flowchart)

Test sequence:



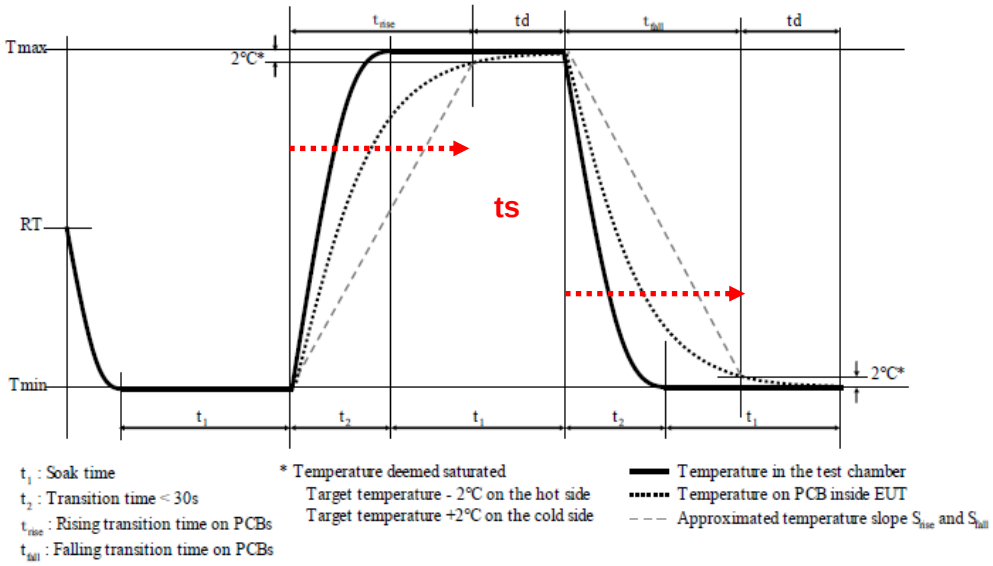
Temperature Cycle Profile:

The transition slope (S_{rise}) and (S_{fall}) are slopes of temperature on PCBs inside EUT. They should be calculated with trise and tfall measured during 1 cycle of CL/01 with assembly. The measuring points on PCB should be agreed with supplier and RENAULT/NISSAN.

S_{rise} = (|Tmax - 2| + |Tmin|) / t_{rise} [℃/min]

S_{fall} = (|Tmax| + |Tmin + 2|) / t_{fall} [℃/min]

CL/01 Figure 2: Measuring the actual ECU temperature profile.



t_1 : Soak time
t_2 : Transition time < 30s
t_{rise} : Rising transition time on PCBs
t_{fall} : Falling transition time on PCBs

* Temperature deemed saturated
Target temperature - 2°C on the hot side
Target temperature +2°C on the cold side

Temperature in the test chamber
Temperature on PCB inside EUT
Approximated temperature slope S_{rise} and S_{fall}

Initial Evaluation of Test:

Before starting the environment test the EUTs shall pass the preceding initial measurement test IM_test (as indicated by the test flow) and may not show any mechanical damage on the visual inspection.

Test procedure:

1. Load EUT inside chamber at room temperature.
2. Begin the cycle with the cold phase and finish by the warm one.
3. Maintain chamber at (Tmin) for (t2 + t1) time.
4. Transfer EUT from (Tmin) to (Tmax) in less than 30s.
5. Maintain chamber at (Tmax) for (t2 + t1) time.
6. Transfer EUT from (Tmax) to (Tmin) in less than 30s.
7. Maintain chamber at (Tmin) for (t2 + t1) time.
8. Redo steps 5) to 8) 199 cycles.
9. Leave EUT in standard atmospheric conditions for a period adequate for the attainment of temperature stability.
10. Perform Final Validation Tests.
11. Extend test to 1000 cycles (characterization only, not validation) for product robustness identification and whiskers investigation.

Acceptance Criteria:

- The EUT shall be fully functional before and after the test and all parameters shall meet the specifications. Verification is done by means of a intermediate measurement test large, IntM_large_test as per Section 11.1.1.3.
- if no damage or anomalies are found on visual inspection following the test.

Validation report:

The following information must be given:

- Measurement of rise/fall time of the ambient and PCB temperature.
- Real curve applied to EUT.
- Pictures of EUT at the end of the test.
- Microsections and final inspections for whiskers analysis.

16.3 CL/02 : THERMAL SHOCKS PRE-AGEING TEST

Test purpose:

Accelerated ageing for the EUT in a test sequence to allow time reduction. The aim of this test is to mechanically age the EUT. This test may also be used as a burn-in thermal shock test settled at the end of the production line to identify and eliminate defective products.

Applicable standards:

RNDS-C-00515 "BASIC PHYSICOCHEMICAL ENVIRONMENTAL SPECIFICATIONS OF ELECTRONIC PARTS Rev 3.0 (2019-09-16);

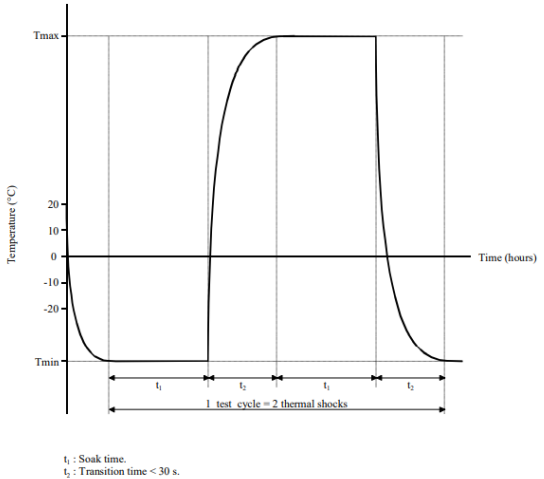
IEC 60068-2-14 "Environmental testing – Part 2-14: Tests – Test N: Change of temperature, Rev.6 (2009-01), Ch.7;

ISO 16750-4 "Road vehicles — Environmental conditions and testing for electrical and electronic equipment — Part 4: Climatic loads" (2010-04-15);

Test Parameters:

Total test duration	50 cycles *90 min= 4 500 min = 75 h =~4 days 20 cycles *90 min = 1 800 min = 30 h=~2 days
Number of Test Cycle (N_{Cycle})	50 cycles when done before CH/08 and CH/12 20 cycles when done before CL/xx, MS/xx (CH/02 legs)
Minimum Storage Temperature (T_{min})	-40°C
Maximum Storage Temperature (T_{max})	+70°C
Holding Time (t_1) at T_{max}, T_{min}	1h after equilibrium time (+15min) =>90min
Equilibrium time	15 min
Transfer Time (t_2) between Chambers	<30s
EUT Test Position	Not relevant
Operating Mode	1.2
Operating class & gravity level	A´/0
Number of samples	6 samples for stand alone test 9 samples for series test (Refer to DV/PV flowchart)

Temperature Cycle Profile:



t_1 : Soak time.
t_2 : Transition time < 30 s.

Initial Evaluation of Test:

Before starting the environment test the EUTs shall pass the preceding initial measurement test IM_test (as indicated by the test flow) and may not show any mechanical damage on the visual inspection.

Test procedure:

A. At the beginning of the test the EUT shall be at the ambient temperature of the laboratory.

B. Place the EUTs in a dual zone thermal shock chamber and adjust the temperature to zones to T_A and T_B.

C. Maintain the EUTs at temperature T_A for the time t_1.

D. Transfer the EUTs from the T_A zone to the T_B zone within t_2.

E. Maintain the EUTs at temperature T_B for the time t_1. F. Transfer the EUT's from the T_B zone to the T_A zone within t_2.

G. Repeat the thermal cycles (steps B through F) for a total number of N_{Cycle}.

H. The EUT's shall then remain under standard atmospheric conditions for the attainment of temperature stability.

Acceptance Criteria:

- The EUT shall be fully functional before and after the test and all parameters shall meet the specifications. Verification is done by means of a intermediate measurement test large, IntM_large_test as per Section 11.1.1.3.
- if no damage or anomalies are found on visual inspection following the test.

Validation report:

The following information must be given:

- Real curve applied to ECU.

16.4 CL/03 : WARM STORAGE

Purpose:

Knowledge of the capacity of a product to be stored, to start and to work in stabilized high temperatures.Resistance of an ECU to functioning at high temperatures. Measure of temperatures reached by critical elements, in the settling phase.

Applicable standards:

RNDS-C-00515 "BASIC PHYSICOCHEMICAL ENVIRONMENTAL SPECIFICATIONS OF ELECTRONIC PARTS Rev 3.0 (2019-09-16);

ISO 16750-4 "Road vehicles — Environmental conditions and testing for electrical and electronic equipment — Part 4: Climatic loads" (2010-04-15);

IEC 60068-2-2 Test B: Dry heat (2007-07);

Test Parameters:

Total test duration	48 h + ramp time
Test duration t1 + t2 time	60 min
Soak time t3	48 h
Maximum Temperature (T_{max})	+70°C
Rate of Temperature Change (T_{Change})	≤1°C/min
Temperature Reference Point	Ambient temperature (chamber temperature)
EUT Test Position	Not relevant
Operating Mode	1.1
Operating class & gravity level	A´ /0
Number of samples	3 samples for stand alone test 9 samples for series test (Refer to DV/PV flowchart)

Initial Evaluation of Test:

Before starting the environment test the EUTs shall pass the preceding initial measurement test IM_test (as indicated by the test flow) and may not show any mechanical damage on the visual inspection.

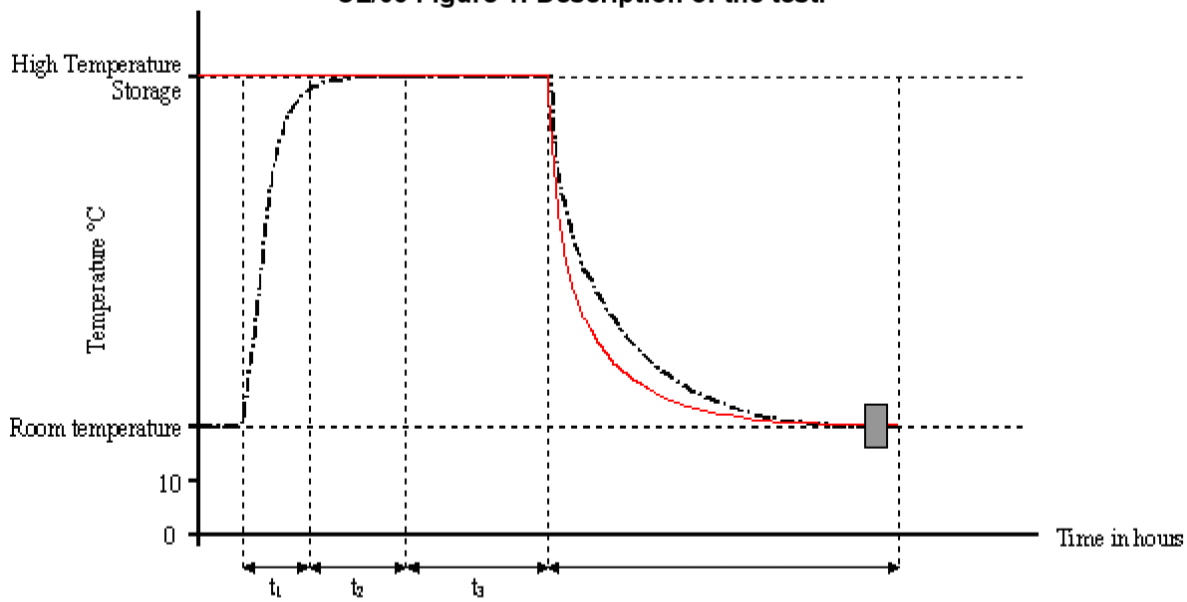
Test procedure:

A. Place the EUTs (EUT temperature is RT) in the temperature chamber at temperature RT;
B. The temperature in the chamber shall then be adjusted to the temperature T_{max} at a rate of temperature change T_{Change};
C. Maintain the DUTs at temperature T_{max} for the time t_3. The duration shall be measured from the time when the temperature stability of the chamber is reached;
D. At the end of this period, the EUTs shall remain in the chamber and the temperature shall be gradually lower at a rate of temperature change T_{Change} to a value lying within the limits of the standard atmospheric conditions for measurements and testing.
E. Remove the EUTs from the chamber.

F. The EUTs shall then remain under standard atmospheric conditions for recovery for a minimum of 1h.

Sequence:

CL/03 Figure 1: Description of the test.



t_1 : Transition time according to IEC 60068-2-2 B
t_2 : Stabilisation time
t_3 : Soak time = 48 h.

EUT temperature
Chamber temperature
Functional check according to product specifications

Acceptance Criteria:

- The EUT shall be fully functional before and after the test and all parameters shall meet the specifications. Verification is done by means of a intermediate measurement test large, IntM_large_test as per Section 11.1.1.3.
- if no damage or anomalies are found on visual inspection following the test.

Validation report:

The following information must be given:

- Real curve applied to ECU.

16.5 CL/04 : COLD STORAGE

Test purpose:

Knowledge of the capacity of a product to be stored, to start and to work in stabilized low temperatures without influence of the altitude.

Applicable standards:

RNDS-C-00515 "BASIC PHYSICOCHEMICAL ENVIRONMENTAL SPECIFICATIONS OF ELECTRONIC PARTS Rev 3.0 (2019-09-16);

ISO 16750-4 "Road vehicles — Environmental conditions and testing for electrical and electronic equipment — Part 4: Climatic loads" (2010-04-15);

IEC 60068-2-1 Test A: Cold(2007-03-01);

Test Parameters:

Total test duration	24 h + ramp time
Test duration (t_1)	24 h
Minimum Temperature (Tmin)	-40°C
Rate of Temperature Change (T_{Change})	≤1°C/min (average over a period of not more than 5 min)
Temperature Reference Point	Ambient temperature (chamber temperature)
EUT Test Position	Not relevant
Operating Mode	1.1
Operating class & gravity level	A´ /0
Number of samples	(Refer to DV/PV flowchart)

Initial Evaluation of Test:

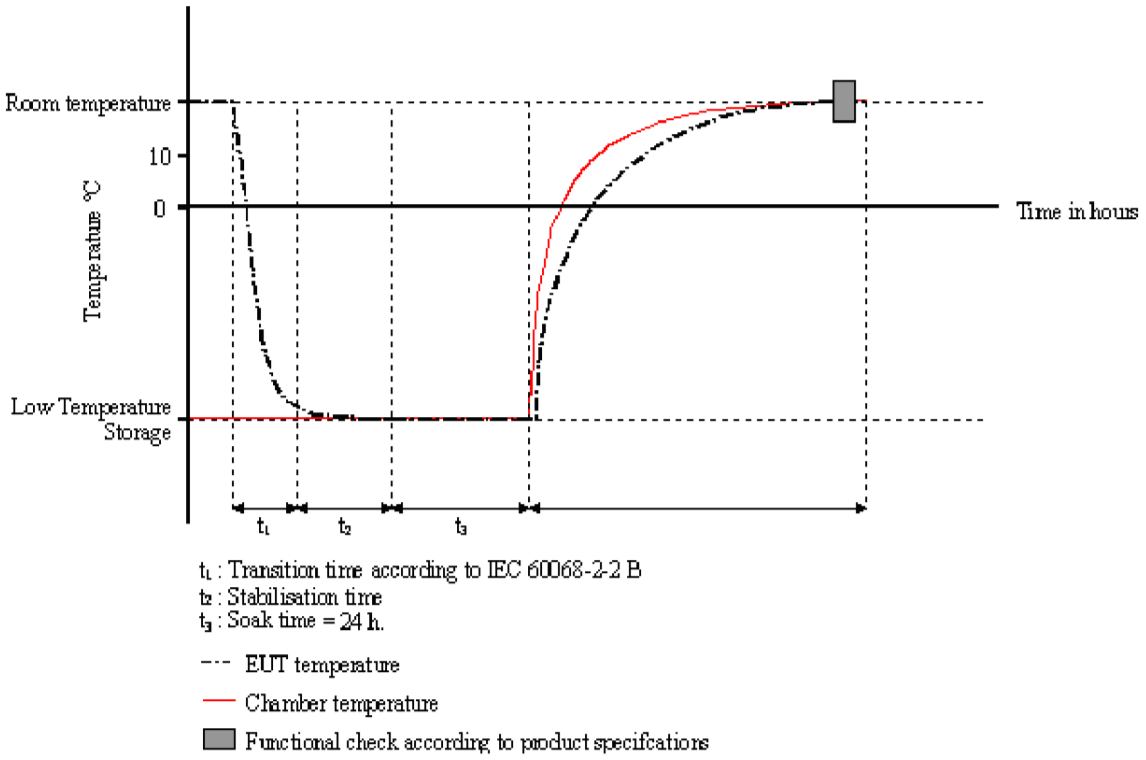
Before starting the environment test the EUTs shall pass the preceding initial measurement test IM_test (as indicated by the test flow) and may not show any mechanical damage on the visual inspection.

Test Procedure:

A. Place the EUTs (EUT temperature is RT) in the temperature chamber at temperature RT.
B. The temperature within the chamber shall then be adjusted to the temperature Tmin at a rate of temperature change T_{Change}.
C. Maintain the EUTs at temperature T_{min} for the time t1. The duration shall be measured form the time when the temperature T_{min} is reached.
D. At the end of this period, the EUTs shall remain in the chamber and the temperature shall be gradually raised at a rate of temperature change T_{Change} to a value lying within the limits of the standard atmospheric conditions for measurement and testing.
E. Remove the EUTs from the chamber.

Sequence:

CL/04 Figure 1: Description of the test.



Acceptance Criteria:

- The EUT shall be fully functional before and after the test and all parameters shall meet the specifications. Verification is done by means of a intermediate measurement test large, IntM_large_test as per Section 11.1.1.3.
- if no damage or anomalies are found on visual inspection following the test.

Validation report:

The following information must be given:

- Real curve applied to ECU.

16.6 CL/06 : CLIMATIC SEQUENCE

Purpose:

The test simulates the use of a system/component under high ambient humidity. The failure modes addressed are electrical malfunctions caused by moisture, for example from leakage current caused by a printed circuit board soaked with moisture.

An additional failure mode is a "breathing effect" that transports moisture inside the housing when the air inside the EUT cools down and ambient air with high humidity is drawn into it.

An additional failure mode is the transport of corrosive additives used in the plastic material to the material surface that can cause corrosion on metallic parts and PCB's used in the DUT. An example of a corrosive halogen is Potassium-Iodide commonly used as temperature stabilizer in PolyAmide (PA).

Applicable standards:

RNDS-C-00515 "BASIC PHYSICOCHEMICAL ENVIRONMENTAL SPECIFICATIONS OF ELECTRONIC PARTS Rev 3.0 (2019-09-16);

ISO 16750-4 "Road vehicles — Environmental conditions and testing for electrical and electronic equipment — Part 4: Climatic loads" (2010-04-15);

IEC 60068-2-38, Test Z/AD (2009);

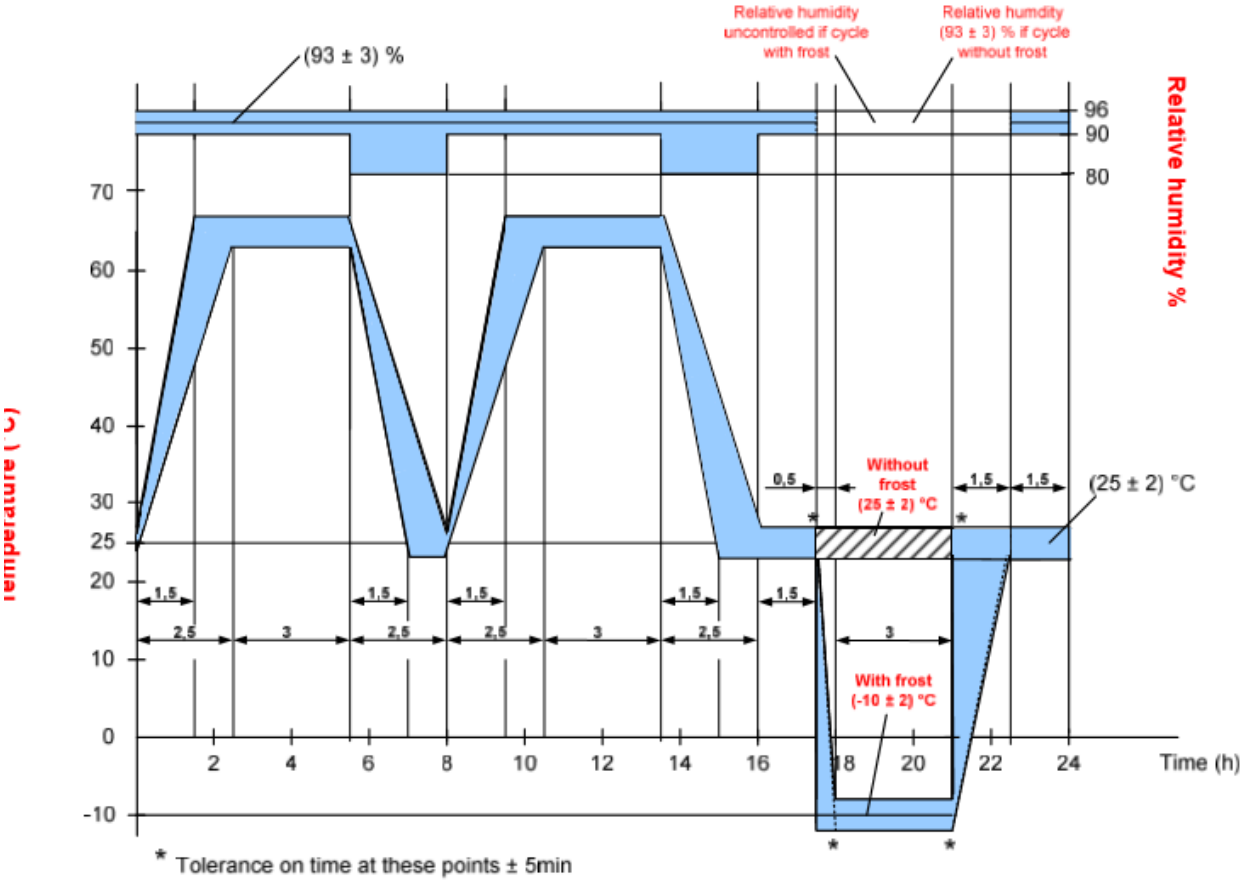
Deviation:

Pre-conditioning for ''assisted drying'' it's not applicable.

Test Parameters:

Total Test Duration	240 h (10 days)
Test Cycle Duration	24 h
Number of Test Cycle (Ncycle)	10
Maximum Temperature (Tmax)	(65 ± 2) °C
Minimum Temperature (Tmin)	(-10 ± 2) °C
Relative Humidity (RH1)	See humidity cycle below
Nominal Power Supply (U_{nom})	14 V± 0.2 V
Temperature Reference Point	Ambient temperature (chamber temperature)
EUT Test Position	In-vehicle mounting orientation (See Ch 10.2)
Operating mode	with electrical operation 1.2/ 3.2 3.2 – (during 15 minutes beginning at the start of each transition from max temperature period and 5 minutes at the end of min temperature period.)
Operating class & gravity level	A/0
Number of samples	3 (Refer to DV/PV flowchart)

Humidity Cycle:



CL/06 Table 1: Test procedure.

Test cycles		Temperature (°C ± 2°C)	Typical duration (hour)	Relative Humidity (% RH)	Power
10 cycles (1 cycle*)	2 cycles	25 → 65	2	90 - 96	ON
		65	3,5	90 - 96	ON
		65 → 25	2	80 - 96	OFF
		25	0,5	80 - 96	ON
	1 cycle	25	1,5	80 - 96	ON
		25 → - 10	0,5(1 minute or the less*)	uncontrolled	OFF
		- 10	3	uncontrolled	OFF
		- 10 → 25	1,5	uncontrolled	ON
		25	1,5	90 - 96	ON

Initial Evaluation of Test:

Before starting the environment test the EUTs shall pass the preceding initial measurement test IM_test (as indicated by the test flow) and may not show any mechanical damage on the visual inspection.

Test Procedure:

A. Adjust a climatic chamber to a temperature (25 ± 2) °C and relative humidity (93 ± 3) RH.

B. Place the EUT (EUT temperature is RT) in the climatic chamber.

C. Perform N cycles of the humidity cycle according to the graph above. Alternate cycle with and without frost (odd cycle with frost).

D. Perform a functional check (in accordance to the operation mode).

E. On completion of the final cycle, the specimen shall be removed from the chamber and shall be kept under standard atmospheric conditions for testing for a period of 24 h before the specified functional test 1 (as indicated in the test flow plan) are made.

Acceptance Criteria:

- The EUT shall be fully functional before and after the test and all parameters shall meet the specifications. Verification is done by means of a intermediate measurement test large, IntM_large_test as per Section 11.1.1.3.
- if no damage or anomalies are found on visual inspection following the test.

Validation report:

The following information must be given:

- Real curve applied to ECU.

16.7 CL/07 : TEMPERATURE RANGE (STEPS) TEST

Purpose:

This test checks the mechanical and electrical device for malfunctions, which may occur within a small section of the operating temperature range. Check if electrical functions, even mechanical ones, and their tolerances are satisfied on the whole range of specified temperature. Knowledge of the evolution of functional classes of the ECU.Verify the ability of electronic components to function inside the ECU temperature range.

Applicable standards:

RNDS-C-00515 "BASIC PHYSICOCHEMICAL ENVIRONMENTAL SPECIFICATIONS OF ELECTRONIC PARTS Rev 3.0 (2019-09-16);

ISO 16750-4 "Road vehicles — Environmental conditions and testing for electrical and electronic equipment — Part 4: Climatic loads" (2010-04-15);

IEC 60068-2-2 Test B:Dry heat(2007-07);

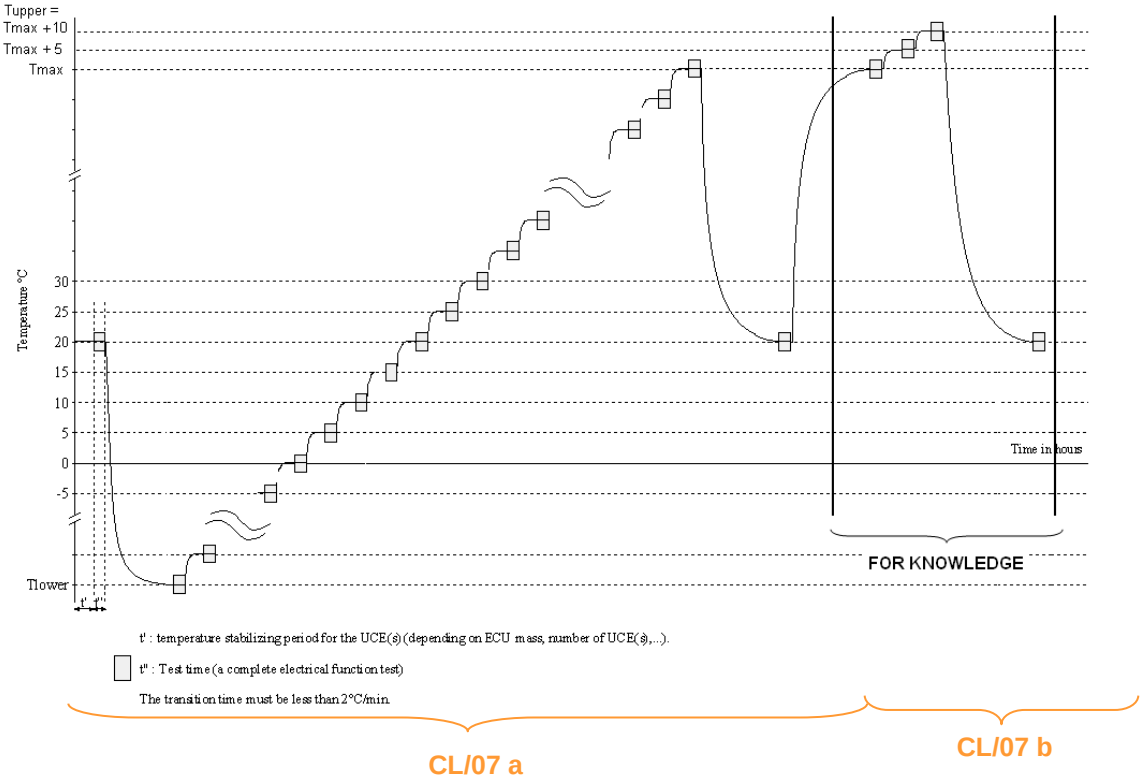
Test Parameters:

Total test duration	1 day
Number of Test Cycle (N_{Cycle})	1
Minimum Storage Temperature (T_{min})	-40°C
Maximum Storage Temperature (T_{max})	+70°C
Upper temperature Tupper (Topmax)	+80°C
Temperature step	5°C
Holding Time at each step	30 min (15 min for temperature stabilization and 15 minutes for test)
Rate of Temperature Change (T_{Change})	1°C/min
Minimum Power Supply (U_{min})	9 (± 2%)V
Nominal Power Supply (U_{nom})	14 (± 2%)V
Maximum Power Supply (U_{max})	16V (± 2%)
EUT Test Position	Not relevant
Operating Mode	3.2
Operating class & gravity level	A/0
Number of samples	3 (Refer to DV/PV flowchart)

Initial Evaluation of Test:

Before starting the environment test the EUTs shall pass the preceding initial measurement test IM_test (as indicated by the test flow) and may not show any mechanical damage on the visual inspection.

Temperature Profile:



Test procedure:

A. Place the EUT in the temperature chamber and stabilize the temperature at RT;
B. Decrease the temperature in steps of 5 °C from RT to T_{min} and then increase the temperature in steps of 5°C from T_{min} to T_{max}.
C. Wait at each step, until the EUT has reached the new temperature. Perform a function test using operation mode 3.2 at each temperature step each voltage level. Between the temperature steps the EUT shall not be operated (1.2);
D. Return the EUT to room temperature (RT).
E. CL/07 (b) performed at the end of the test leg. Increase the temperature in steps of 5°C from T_{max} to T_{opmax}.
F. Return the EUT to room temperature (RT).

Acceptance Criteria:

- The EUT shall be fully functional before and after the test and all parameters shall meet the specifications. Verification is done by means of a intermediate measurement test large, IntM_large_test as per Section 11.1.1.3.
- if no damage or anomalies are found on visual inspection following the test.

Validation report:

The following information must be given:

- Real curve applied to ECU.

16.8 CL/08 : WARM OPERATION

Purpose:

Burn-in test at high temperatures settled at the end of the production line to identify and eliminate defective products.

Applicable standards:

RNDS-C-00515 "BASIC PHYSICOCHEMICAL ENVIRONMENTAL SPECIFICATIONS OF ELECTRONIC PARTS Rev 3.0 (2019-09-16);

ISO 16750-4 "Road vehicles — Environmental conditions and testing for electrical and electronic equipment — Part 4: Climatic loads" (2010-04-15);

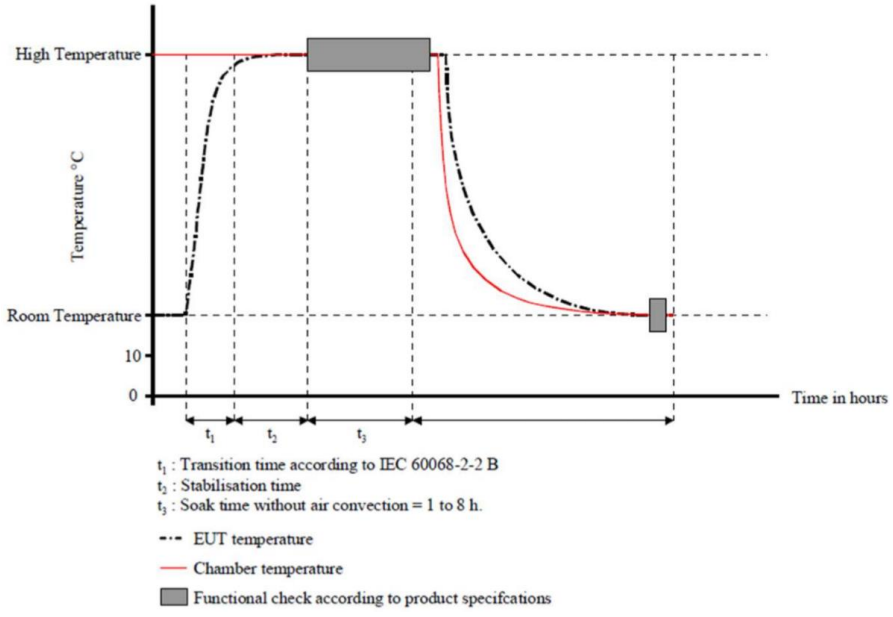
IEC 60068-2-2 Test B: Dry heat (2007-07-01);

Test Parameters:

Number of cycles (Ncycle)	1
Test duration t1 + t2 time	60 min
Soak time t3	8 h
Maximum Temperature (T_{max})	Topmax = +70°C
Rate of Temperature Change (T_{Change})	1°C/min
Temperature Reference Point	Ambient temperature (chamber temperature)
Nominal Power Supply (U_{nom})	14 V± 0.2 V
EUT Test Position	Not relevant
Operating Mode	3.2
Operating class & gravity level	A/0
Number of samples	3 (Refer to DV/PV flowchart)

***Note**: It is recommended to test without air convection in the chamber because it is more realistic.

Description of the test:



Initial Evaluation of Test:

Before starting the environment test the EUTs shall pass the preceding initial measurement test IM_test (as indicated by the test flow) and may not show any mechanical damage on the visual inspection

Test procedure:

A. Place the EUTs (EUT temperature is RT) in the temperature chamber at temperature RT.
B. Increase the climatic chamber temperature T_{max} at a rate of temperature change T_{Change}.
C. Maintain the EUTs at temperature T_{opmax} for the 8h. The duration shall be measured form the time when the temperature T_{opmax} is reached.
D. At the end of this period, the EUTs shall remain in the chamber and the temperature shall be gradually lower at a rate of temperature change T_{Change} to a value lying within the limits of the standard atmospheric conditions for measurement and testing.
E. Remove the EUTs from the chamber.
F. If there are any water droplets on the surface of the test samples, remove them thoroughly (using dry cloth or tissue).
G. The EUTs shall then remain under standard atmospheric conditions for recovery for 2h.

Acceptance Criteria:

- The EUT shall be fully functional before and after the test and all parameters shall meet the specifications. Verification is done by means of a intermediate measurement test large, IntM_large_test as per Section 11.1.1.3.
- if no damage or anomalies are found on visual inspection following the test.

Validation report:

The following information must be given:

- Real curve applied to ECU.

16.9 CL/09: COLD OPERATION

Purpose:

Knowledge of the capacity of a product to start and to work in stabilized low temperatures. An application of this test depends on mechanical structure of ECU that has sticking movement under cold atmosphere.

Applicable standards:

RNDS-C-00515 "BASIC PHYSICOCHEMICAL ENVIRONMENTAL SPECIFICATIONS OF ELECTRONIC PARTS Rev 3.0 (2019-09-16);

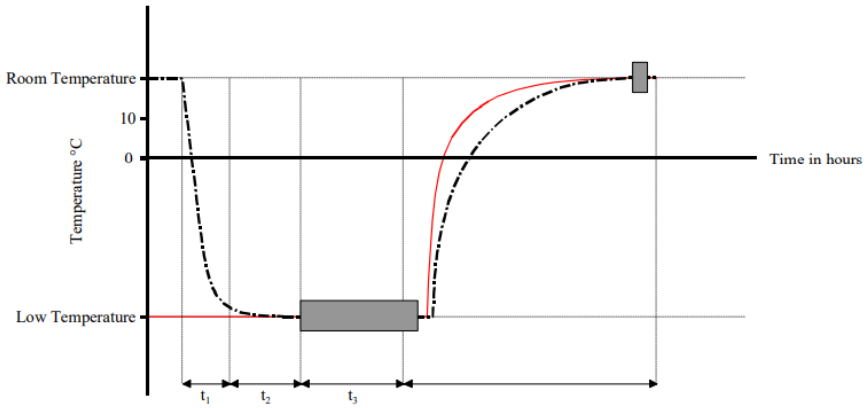
ISO 16750-4 "Road vehicles — Environmental conditions and testing for electrical and electronic equipment — Part 4: Climatic loads" (2010-04-15);

IEC 60068-2-1 Test A: Cold(2007-03-01);

Test Parameters:

Total test duration	24 h + ramp time
Number of cycles (N_{cycles})	1
Minimum Temperature (Topmin)	Topmin =-40°C
Soak duration (t_3)	24 h
Stabilization time t_2	30 min
Soak time t3' IGN ON	1h
Soak time t3'' IGN OFF	1h
Number of ON/OFF cycles	12
Operating voltage	14 V± 0.2 V @ operating mode 3.2
Rate of Temperature Change (T_{Change})	≤1°C/min
Temperature Reference Point	Ambient temperature (chamber temperature)
EUT Test Position	Not relevant
Operating Mode	3.2 when IGN ON 1.2 when IGN OFF
Operating class & gravity level	A /0
Number of samples	3 (Refer to DV/PV flowchart)

Description of the test:

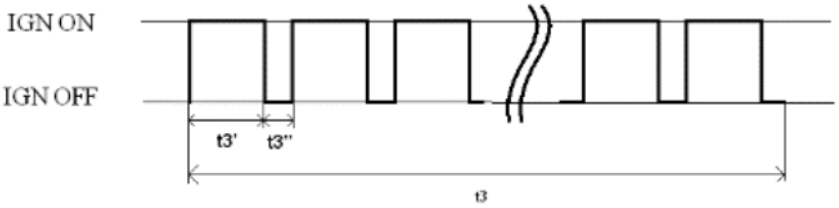


t_1 : Transition time according to IEC 60068-2-2 B
t_2 : Stabilisation time
t_3 : Soak time without air convection = 24 h.

EUT temperature

Chamber temperature

Functional check according to product specifcations



t3 = 24 h
t3' = 1 h as a minimum
t3'' = time required for the EUT to be again at Tmin
Number of ON/OFF cycles : 12 as a minimum

Initial Evaluation of Test:

Before starting the environment test the EUTs shall pass the preceding initial measurement test IM_test (as indicated by the test flow) and may not show any mechanical damage on the visual inspection.

Test Procedure:

A. Place the EUTs (EUT temperature is room temperature) in the temperature chamber at room temperature;
B. The temperature within the chamber shall then be adjusted to temperature T_{opmin} at a rate of temperature change T_{Change} ;
C. Maintain and operate the EUTs at temperature T_{opmin} for 24h. The duration shall be measured form the time when the temperature T_{opmin} is reached;
D. Start monitoring the parts for t_3. Perform 12 ON/OFF cycles (t3' = t3'' = 1h)
E. At the end of this period, the specimen shall remain in the chamber and the temperature shall be gradually raised at a rate of temperature change T_{Change} to a value which is within the limits of the standard atmospheric conditions for measurement and testing;
F. Remove the EUTs from the chamber;
G. To remove droplets of water, the EUT may be shaken by hand or a blast of air at laboratory temperature may be applied for a short time;
H. Before any other test, the EUTs shall then remain under standard atmospheric conditions for recovery for at least 2h.

Acceptance Criteria:

- The EUT shall be fully functional before and after the test and all parameters shall meet the specifications. Verification is done by means of a intermediate measurement test large, IntM_large_test as per Section 11.1.1.3.
- if no damage or anomalies are found on visual inspection following the test.

Validation report

The following information must be given:

- Real curve applied to ECU.

16.10 CL/10: COLD AND LOW PRESSURE STORAGE

Purpose:

Knowledge of the capacity of a product to be stored in stabilized low temperatures with influence of the altitude. This test is applicable only in case of transportation by old type airplane with cold and low pressure atmosphere.

Applicable standards:

RNDS-C-00515 "BASIC PHYSICOCHEMICAL ENVIRONMENTAL SPECIFICATIONS OF ELECTRONIC PARTS Rev 3.0 (2019-09-16);

ISO 16750-4 "Road vehicles — Environmental conditions and testing for electrical and electronic equipment — Part 4: Climatic loads" (2010-04-15);

IEC 60068-2-40 Z/AM: Combined cold/low air pressure tests

Test Parameters:

Total test duration	1 day
Number of cycles (N_{cycles})	1
Minimum Temperature (Tmin)	Tmin =-55°C
Absolute pressure	40 kPa
Soak duration at -55°C and 40kPa	20 h
EUT Test Position	Not relevant
Operating Mode	1.1
Operating class & gravity level	A´ /0
Number of samples	9 (Refer to DV/PV flowchart)

Initial Evaluation of Test:

Before starting the environment test the EUTs shall pass the preceding initial measurement test IM_test (as indicated by the test flow) and may not show any mechanical damage on the visual inspection.

Test Procedure:

A. Put the EUT at ambient temperature and pressure in a pressure box.
B. Place the pressure box in a thermal chamber at RT.
C. Decrease thermal chamber T down to -55°C over 1h. Wait 3h until the box and the parts inside have stabilized at -55°C.
D. After 3h, decrease pressure down to 40 kPa. Verify that rate of change of pressure does not exceed 10 kPa per minute.
E. Wait till EUT temperature has stabilized at -55°C and air pressure at 40 kPa.
F. Leave EUT for 20 hours under these conditions.
G. Restore chamber pressure to normal at a rate not exceeding 10kPa per minute.
H. During pressure increase, temperature control is not required.

Acceptance Criteria:

- The EUT shall be fully functional before and after the test and all parameters shall meet the specifications. Verification is done by means of a intermediate measurement test large, IntM_large_test as per Section 11.1.1.3.
- if no damage or anomalies are found on visual inspection following the test

Validation report:

The following information must be given:

- Real curve applied to ECU.

16.11 CL/13 : CHECK OF SATURATION TEMPERATURE

Preliminary test - To be performed at the beginning of DV.

Test purpose:

This test is conducted to measure the saturation temperature of elements/materials and the time required for this saturation through the temperature rise due to the operation of electronic equipment, and to determine if all components have a case temperature below its specifications (ex Tj, Tg).

Applicable standards:

RNDS-C-00515 "BASIC PHYSICOCHEMICAL ENVIRONMENTAL SPECIFICATIONS OF ELECTRONIC PARTS Rev 3.0 (2019-09-16);

Test parameters:

Number of cycles (N_{cycles})	1 per activation profile
Maximum temperature T_{max}	Topmax = +70 °C for validation
Nominal Power Supply (U_{nom})	14 V± 0.2 V
EUT Test Position	In-vehicle mounting orientation (See Ch 10.2)
Operating Mode	3.2 (HW bench)
Operating class & gravity level	A /0
Number of samples	2 (Refer to DV/PV flowchart) 1 for infrared camera 1 for thermocouple

Activation profiles:

Activation profile	Air temperature	Vehicle ON? (for engine compartment and outside ECUs)
Profile 1	Tair_1 °C	Y/N
Profile 2	Tair_2 °C	Y/N
…	…	…
Profile 70	Tair_70 °C	Y/N

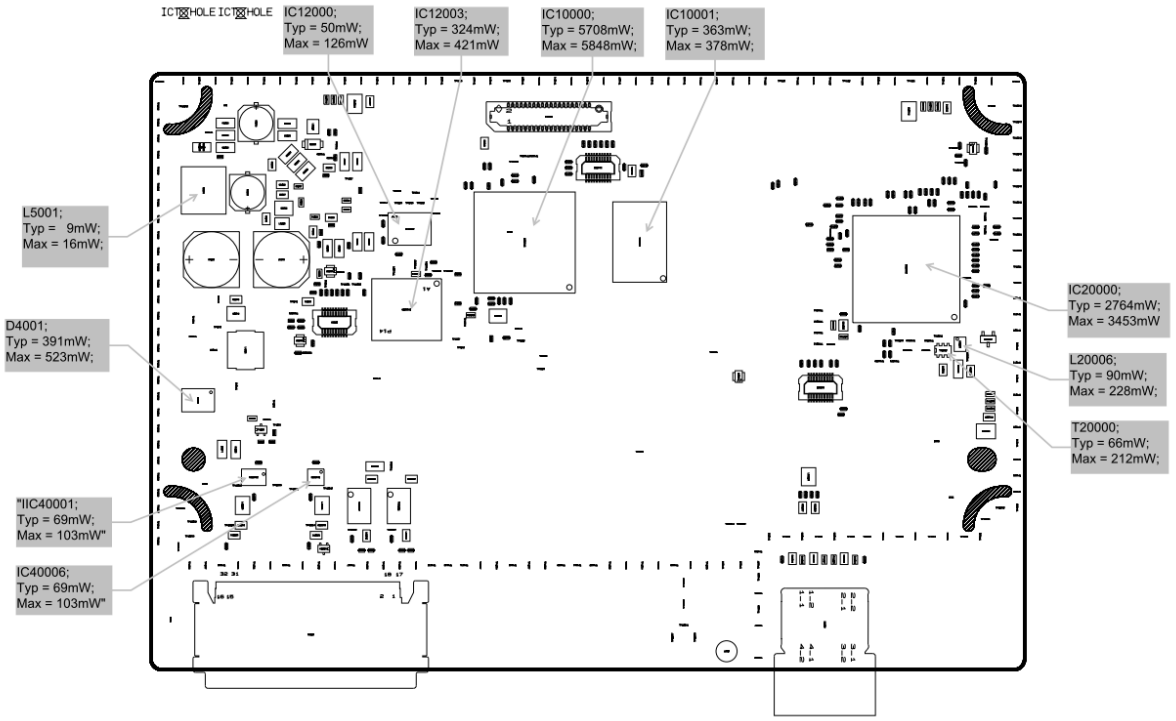
Initial Evaluation of Test:

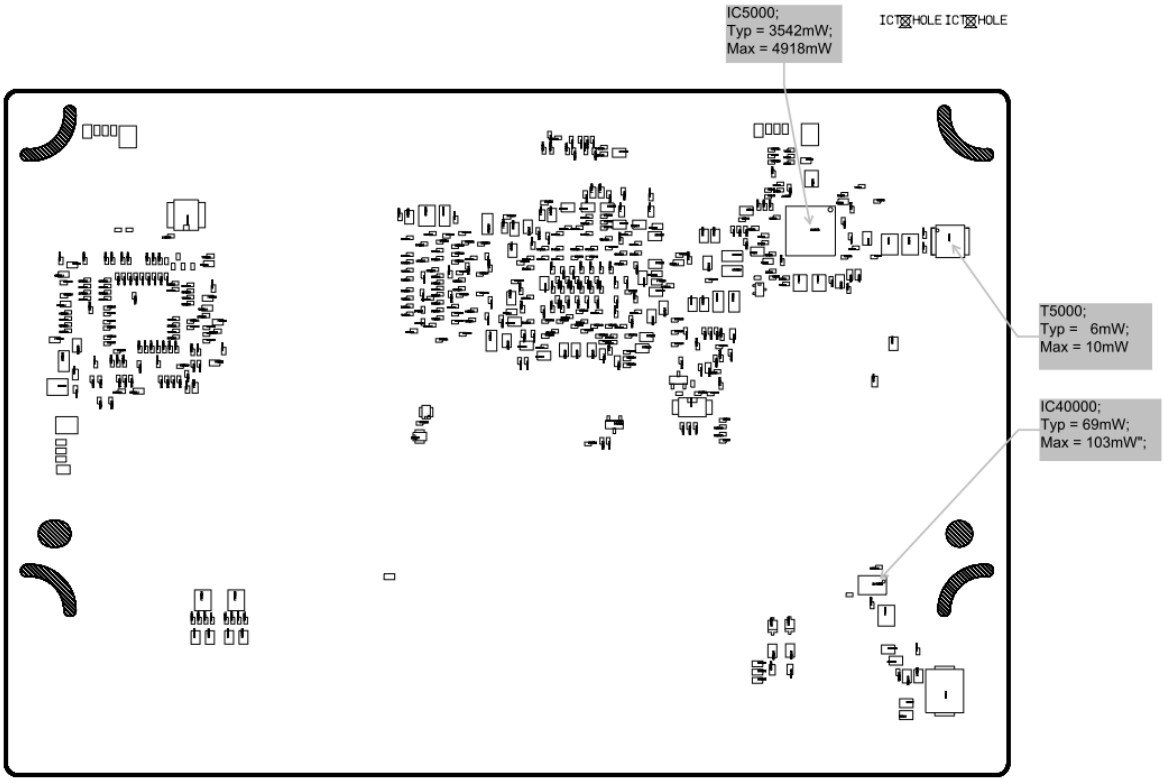
Before starting the environment test the EUTs shall pass the preceding initial measurement test IM_test (as indicated by the test flow) and may not show any mechanical damage on the visual inspection.

Test Procedure:

1. Firstly use an infrared camera to perform the test.
2. Close the ECU with a transparent film (from a thermal point of view) to reproduce the real condition.
3. Provide in validation report the Infra Red thermography pictures.
4. Check results of camera investigation and start measurement using thermocouples.
5. Stick a thermocouple onto the surface of any of the hottest components/elements identified during thermography test while performed with maximum self heating.(see Thermocouples placement description below).
6. Place the EUT in a thermostatic chamber in which the temperature is adjusted to room temperature.
7. Put EUT inside chamber in car mounting representative position.
8. Fix cable harnesses in car mounting representative position
9. Place the input unit and the load unit outside the chamber to operate the EUT.
10. Connect the input unit and the load unit to operate the EUT.
11. Increase the temperature in the thermostatic chamber gradually to Tmax.
12. After reaching Tmax, wait 1h ± 0.5h for EUT temperature stabilization.
13. Set the power supply voltage to Ua = 14.0 ± 0.2 V.
14. At Tmax, and for each activation profile.
    Operate EUT until each thermocouple has reached a steady temperature
    For each thermocouple, record
    - its steady temperature.
    - the time for reaching its steady temperature.

Thermocouples placement :





The following shall be noted during this confirmation test.

Installation of equipment :

The load shall be connected (the input unit and the load equivalent to actual load shall be connected outside of the thermostatic chamber) to operate the EUT. The assembly direction of the EUT shall be the same in the actual conditions. When radiation of heat from the applicable electronic equipment is prevented due to its structure, such structure shall be simulated when the EUT is assembled. As for temperature sensors to be installed, a bare thermocouple shall be used in which the thermal capacity is considerably lower than the one of the EUT, so the ambient temperature is not affected.

If it is clear that the load location in the actual vehicle is the same as the layout of the EUT and the load, the load can be placed in the thermostatic chamber during this test.

Selection of temperature measurement points :

When selecting temperature measurement points, heat-sensitive elements/materials/areas shall be selected after considering heat-transfer system such as conduction, radiation and convection. Prior to the test, the temperature inside the EUT shall also be measured using thermocouple, visualizing device (like Infra Red thermography pictures), calculations/simulations, etc. at normal ambient temperature to determine the temperature distribution.

Based on the collected data such as temperature rise of heating elements as well as elements/materials/areas under the influence of such heat, measurement points shall be selected in consideration.

The following are the examples of areas to be measured.

- Heat sources inside of the EUT.
- Elements and materials to be exposed to heat near heat sources inside of the EUT.
- Heat-sensitive elements and materials.

Acceptance Criteria:

- The EUT shall be fully functional before and after the test and all parameters shall meet the specifications.
- if no damage or anomalies are found on visual inspection following the test;

Validation report:

The following information must be given:

- Picture to see where the sensors have been located;
- Curves of these sensors to see the temperature rise;
- Infra red thermography pictures;
- Results of simulation if applicable;
- Table with the value of the specification compared to temperature measured.

16.12 CL/15 : CONTINUOUS HUMIDITY TEST

Purpose:

This test generates chemical failures. This standard is applied to a combination of devices and materials that constitutes units and parts.

<1>The combination of those different materials, or even a combination of chemicals that are used in manufacturing processes induce chemical reactions, which both middle temperature and high humidity may accelerate. Such a combination can be applied to the evaluation of elements that are feared to undergo degradation or fatigue.

<2>This test can evaluate chemical reaction by halogen that has low sublimination temperature .

<3>This test can also evaluate any metallurgical phenomenon that can occur under middle temperature and high humidity

Applicable standards:

RNDS-C-00515 “BASIC PHYSICOCHEMICAL ENVIRONMENTAL SPECIFICATIONS OF ELECTRONIC PARTS Rev 3.0 (2019-09-16);

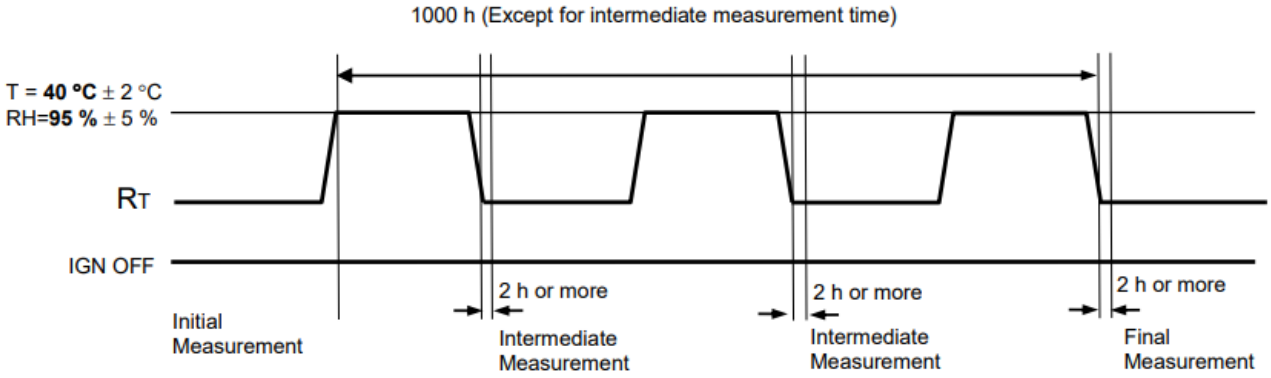
***Note 1: For **CL/15 test** the Initial Measurement test (IM_Test) will be performed at room temperature (RT) and nominal voltage (Unom =14±0,5V) only.

***Note 2: Before executing CL/15, EUT should not be exposed more than 30 degrees Celsius. Because EUT should not be exposed at high temperature to avoid to go away halogen ingredient.This test shall be evaluated individual and shall not be built into test sequence.

Test Parameters:

Total test duration	1000 h~ 42 days ~ 6 CW
Number of cycles (N_{cycles})	1
Test Temperature	+40°C ± 2°C
Relative humidity	95 ± 5% RH
Intermediate measurement	after 300 h and 600 h from beginning
EUT Test Position	In-vehicle mounting orientation (See Ch 10.2)
Operating Mode	1.2
Operating class & gravity level	A´ /0
Number of samples	3 (Refer to DV/PV flowchart)

High humidity and Middle temperature deterioration test pattern:



Initial Evaluation of Test:

Before starting the environment test the EUTs shall pass the preceding initial measurement test IM_test only at RT(as indicated by the test flow) and may not show any mechanical damage on the visual inspection.

Test Procedure:

a) Place the EUTs in a climatic chamber which is set at Room Temperature (RT).
b) Mount EUT inside chamber in car mounting representative position.
c) Fix cable harnesses in car mounting representative position.
d) Increase the climatic chamber temperature to 40°C and the relative humidity to 95%.
e) Leave the EUT at this test condition until intermediate or final measurement.
f) At 300 hrs, 600 hrs and 1000 hrs, get the climatic chamber temperature back to RT and to room humidity prior to remove from chamber and disconnect the EUT for mesurement.
g) before conduct intermediate and final measurement, take out EUTs from chamber and leave EUTs at RT (Room Temperature) for 2 hours or more.
h) After intermediate measurement repeat the test setup sequence a) to g) until final measurement.

Acceptance Criteria:

- The EUT shall be fully functional before and after the test and all parameters shall meet the specifications. Verification is done by means of a intermediate measurement test large, IntM_large_test as per Section 11.1.1.3.
- if no damage or anomalies are found on visual inspection following the test

Validation report:

The following information has to be given:

- Real curve applied to ECU.

17 CHEMICAL TESTS -CH

17.1 CH/01 : SOLID TIGHTNESS TEST

Test purpose:

Knowledge of the behavior of a material in an atmosphere loaded with fine particles of size < 150 µm as it is when we have simultaneously a condition of aridity of the ground and a condition of mechanical air mixing (wind).

This test is not intended to stimulate phenomena of erosion and we can notice that the conditions of the test are such as the effects of superficial abrasion, during the impact of dusts in the exposed material, are unimportant. It aims to verify:

- The resistance of the material.
- Functioning under or after exposure.
- The efficiency of bonnets and cases as protections.
- Solid proofness

Applicable standards:

RNDS-C-00515 “BASIC PHYSICOCHEMICAL ENVIRONMENTAL SPECIFICATIONS OF ELECTRONIC PARTS Rev 3.0 (2019-09-16);

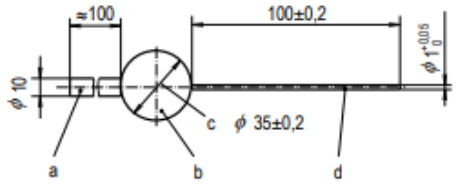
ISO 20653 “Road vehicles — Degrees of protection (IP code) — Protection of electrical equipment against foreign objects, water and access“ (2013-02-15);

ISO 16750-4 “Road vehicles — Environmental conditions and testing for electrical and electronic equipment — Part 4: Climatic loads“ (2010-04-15), Ch.5.10

Test Parameters:

Total Test Duration	1 day
Proitection class (IP code)	IP 42
Protection against ingress of	solid foreign objects diameter ≥ 1,0 mm Wire with diameter 1,0 mm shall not penetrate
Test equipment	wire 100mm long - 1mm diameter
Insertion force	1 N ±10%
Test Temperature	RT (Room temperature)
Test points:	connectors, housing interface
EUT Test Position	In-vehicle mounting orientation (See Ch 10.2)
Operating Mode	1.2
Operating class & gravity level	A´/0
Number of samples	3 (Refer to DV/PV flowchart)

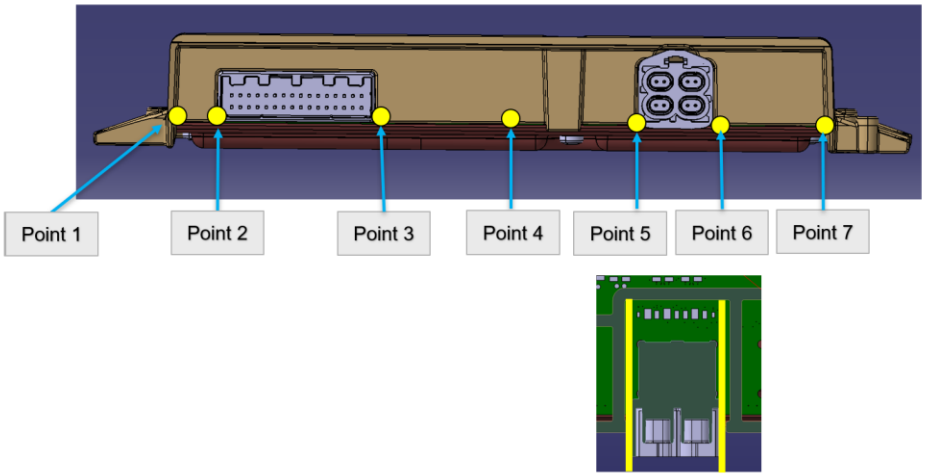
CH/01 Table 1: Probes for the testing of degrees of protection against ingress of foreign objects and contact with hazardous parts.

Degree of protection against ingress of foreign objects First digit	Probe	
4	Test wire diameter 1,0, length 100 	Dimensions in millimeters Key: a. handle (insulating material) b. stop face c. ball d. rigid test wire (metal)

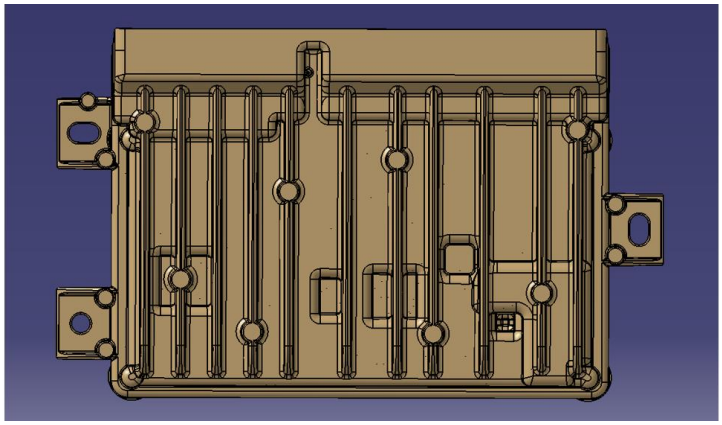
CH/01 Table 2: Degrees of protection against ingress of foreign objects (including dust) and contact with hazardous parts

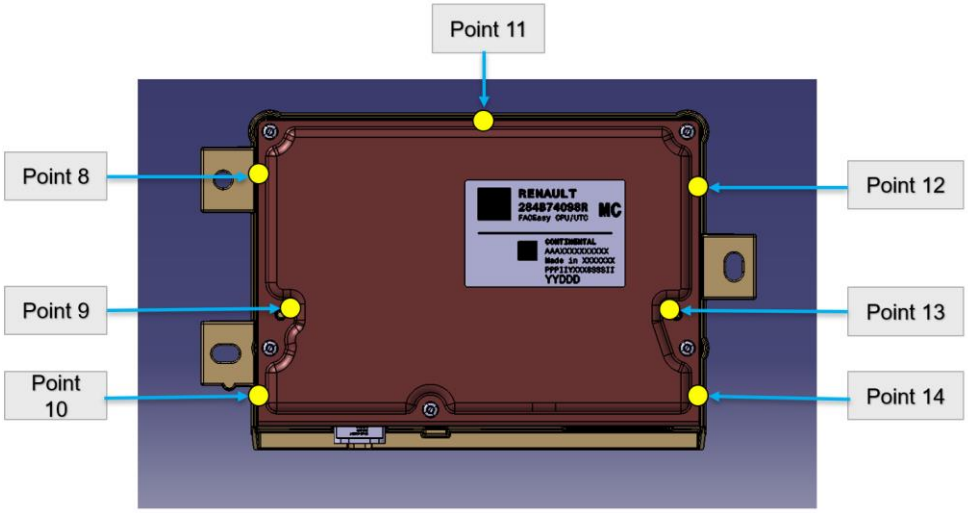
First code digit / supplementary letter	Short description	
	Protection against ingress of	Requirements
4	solid foreign objects diameter ≥ 1,0 mm	Wire with diameter 1,0 mm shall not penetrate

Testing points definition:

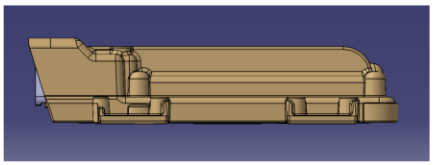


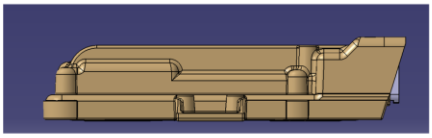
In this view are not possible to put in with the wire into unit.

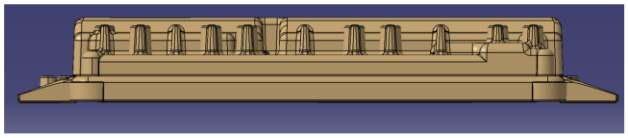




In this views are not possible to put in with the wire into unit.







Initial Evaluation of Test:

Before starting the environment test the EUTs shall pass the preceding initial measurement test IM_test (as indicated by the test flow) and may not show any mechanical damage on the visual inspection.

Test Procedure:

A. Connect original connectors to the EUTs;

B. At room temperature RT, check using the test probe for protection of the EUT against acces, according to the pictures below.

C. Following the test, one of the EUT shall be disassembled for disassembly examinations.

Acceptance Criteria:

- The EUT shall be fully functional before and after the test and all parameters shall meet the specifications. Verification is done by means of a intermediate measurement test large, IntM_large_test as per Section 11.1.1.3.
- if no damage or anomalies are found on visual inspection following the test.

If the EUT is visibly damaged, all incidents of damage shall be documented in the test report with pictures of external/internal aspect of the EUT.

17.2 CH/02 : WATER TIGHTNESS TEST

A. CH/02: WATER TIGHTNESS TEST. CHARACTERIZATION TEST ONLY

Test purpose:

Evaluates EUT protection level when exposed to water. This test is applicable to the materials susceptible to be exposed to rain, water streaming and water projection with or without pressure. It aims to verify:

- The resistance of the material.
- Functioning under or after exposure.
- The efficiency of bonnets and cases as protections.
- Waterproofness.

Applicable standards:

RNDS-C-00515 "BASIC PHYSICOCHEMICAL ENVIRONMENTAL SPECIFICATIONS OF ELECTRONIC PARTS Rev 3.0 (2019-09-16);

ISO 20653 "Road vehicles — Degrees of protection (IP code) — Protection of electrical equipment against foreign objects, water and access" (2013-02-15);

ISO 16750-4 "Road vehicles — Environmental conditions and testing for electrical and electronic equipment — Part 4: Climatic loads" (2010-04-15), Ch.5.10

Test Parameters:

Total Test Duration		1 day	
Proitection class (IP code)		IP 42	
Test Temperature		RT (Room temperature)	
Protection against ingress		water drips with enclosure inclined by 15º	
EUT Test Position		In-vehicle mounting orientation with dummy tightness harness (See Ch 10.2)	
Operating Mode		1.2	
Operating class & gravity level		A´/0	
Number of samples		Refer to DV/PV flowchart	
Drip Water			
Water Temperature (T_{Water})		T_{EUT} ± 5 °C	
Water Flow Rate		(3,0 ± 0,5) mm/min (precipitation height)	
Test Orientation Profile			
Test Position	15° Tilt about the	In the Direction of the	Test Duration (t1)
1	X axis	+ X axis	2,5 min for each of the four position
2		-X axis	
3	Y axis	+ Y axis	
4		-Y axis	

***Note:** Vertical drips shall not have any harmful effects.

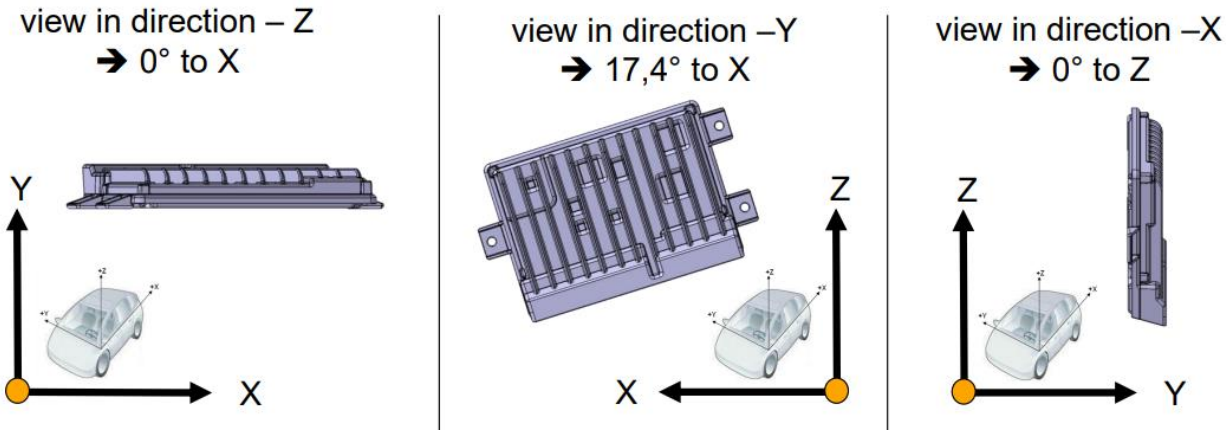
Specific requirments:

CH/02 test does not forbid water income within ECU.

But, in case of water ingress, calculator still have to be functional. Also in case of water ingress and when ECU is activated according to its mission profile, supplier have to guarantee there is no risk of thermal incident.

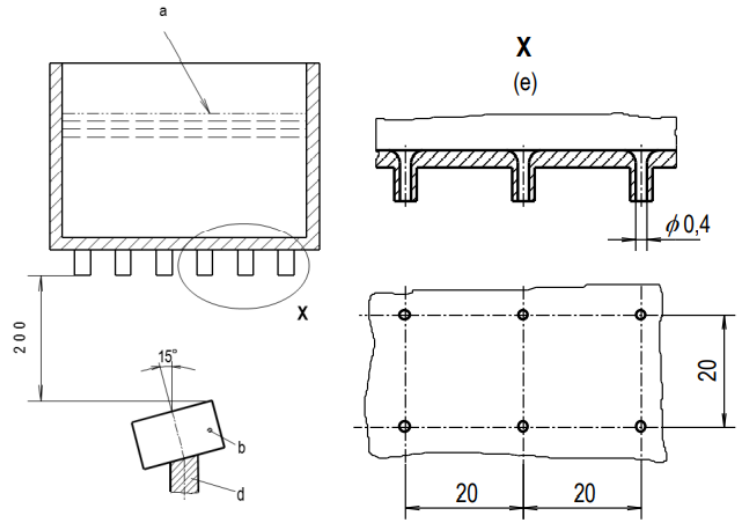
As demineralised water will have insulating effect (no minerals, no ions), non conductive water must not be used for CH/02 performance.

EUT test position:



Test equipment:

CH/02 Table 3: Description of the water test equipments.

Degree of protection against ingress of water	Test set-up and spatial arrangement with reference to the equipment under test
2	Protection against vertical water drops (drip box)  Dimensions in millimeters Key: a. adjustable water level b. equipment under test c. turntable d. support e. hole grid pattern (sectional drawing)

Initial Evaluation of Test:

Before starting the environment test the EUTs shall pass the preceding initial measurement test IM_test (as indicated by the test flow) and may not show any mechanical damage on the visual inspection.

All parts MUST be identified and weighed (without harness and/or connector)one by one before the test and pictures of the weigh-in taken and included in the test report.

Test Procedure:

Connect original connectors to the EUT.

A. Adjust the flow rate of the drip water according the parameter given above
B. Each EUT shall be attached to the spray chamber turntable and tested in each of the (4) fixed position(s) of 15° tilt described above.
C. The drip box shall be positioned 200 mm from the very topmost component of the EUT.
D. Subject each EUT to a uniform flow of water drops (drip water) over the entire exposed surface area for the time t1. The turntable shall not rotate during test.
E. Repeat step B to D for the remaining test positions.
F. Following the test, one of the EUT shall be disassembled for disassembly examinations.

Do not open the EUT before performing the intermediate measurement test small (room temperature only)

Immediately after the test, the EUT shall be taken out of water and final measurements.

Acceptance Criteria:

- The EUT shall be fully functional before and after the test and all parameters shall meet the specifications. Verification is done by means of a intermediate measurement test large, IntM_large_test as per Section 11.1.1.3.
- if no damage or anomalies are found on visual inspection following the test.
- Water drips with enclosure inclined 15° must not influence the functionality of the EUT.

If the DUT is visibly damaged, all incidents of damage shall be documented in the test report with pictures of external/internal aspect of the EUT.

Weight the EUTs:

Weigh EUT will be done as following:
• The weight of the EUTs to be weighed without connectors before the test;
• Remove the water from the EUT surfaces.
• The weight of the EUTS to be weighed without connectors after the test;
• EUTs weighing will be made with a calibrated scale tool.
• After test, EUTs must be between ± 5% tolerances.

B. CH/02: WATER TIGHTNESS TEST – DV/PV VALIDATION

Test purpose:

Evaluates EUT protection level when exposed to water. This test is applicable to the materials susceptible to be exposed to rain, water streaming and water projection with or without pressure. It aims to verify:

- The resistance of the material.
- Functioning under or after exposure.
- The efficiency of bonnets and cases as protections.
- Waterproofness.

All parts MUST be identified and weighed (without harness and/or connector) one by one before and after the test and pictures of the weigh-in taken and included in the test report.

Applicable standards:

RNDS-C-00515 "BASIC PHYSICOCHEMICAL ENVIRONMENTAL SPECIFICATIONS OF ELECTRONIC PARTS Rev 3.0 (2019-09-16);

ISO 20653 "Road vehicles — Degrees of protection (IP code) — Protection of electrical equipment against foreign objects, water and access" (2013-02-15);

ISO 16750-4 "Road vehicles — Environmental conditions and testing for electrical and electronic equipment — Part 4: Climatic loads" (2010-04-15), Ch.5.10

Test Parameters:

Total Test Duration		1 day	
Proitection class (IP code)		IP 42	
Test Temperature		RT (Room temperature)	
Protection against ingress		water drips with enclosure inclined by 15º	
EUT Test Position		Check pictures EUT test position (X, Y) below, with dummy tightness harness	
Operating Mode		1.2	
Operating class & gravity level		A´/0	
Number of samples		Refer to DV/PV flowchart	
Drip Water			
Water Temperature (T_{Water})		T_{EUT} ± 5 °C	
Water Flow Rate		(3,0 ± 0,5) mm/min (precipitation height)	
Test Orientation Profile			
Test Position	15° Tilt about the	In the Direction of the	Test Duration (t1)
1	X axis	+ X axis	2,5 min for each of the four position
2		-X axis	
3	Y axis	+ Y axis	
4		-Y axis	

***Note:** Vertical drips shall not have any harmful effects.

Specific requirments:

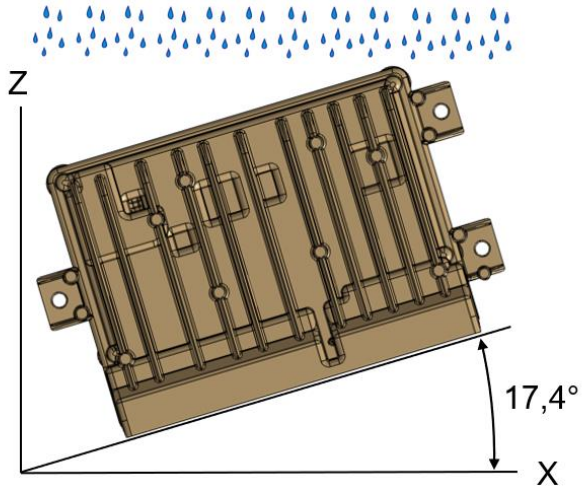
CH/02 test does not forbid water income within ECU.

But, in case of water ingress, calculator still have to be functional. Also in case of water ingress and when ECU is activated according to its mission profile, supplier have to guarantee there is no risk of thermal incident.

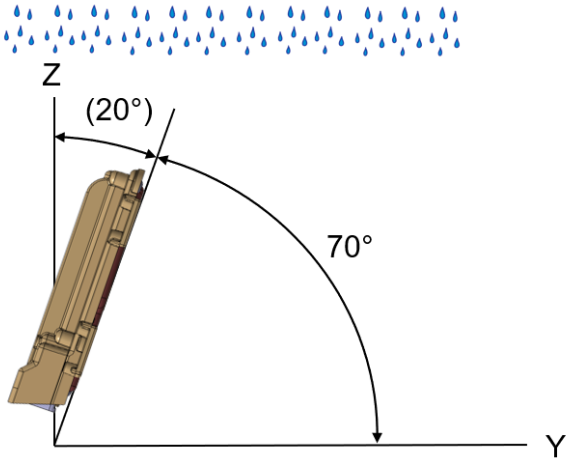
As demineralised water will have insulating effect (no minerals, no ions), non conductive water must not be used for CH/02 performance.

EUT test position:

› view from the front
➔ 17,4° to horizontal X



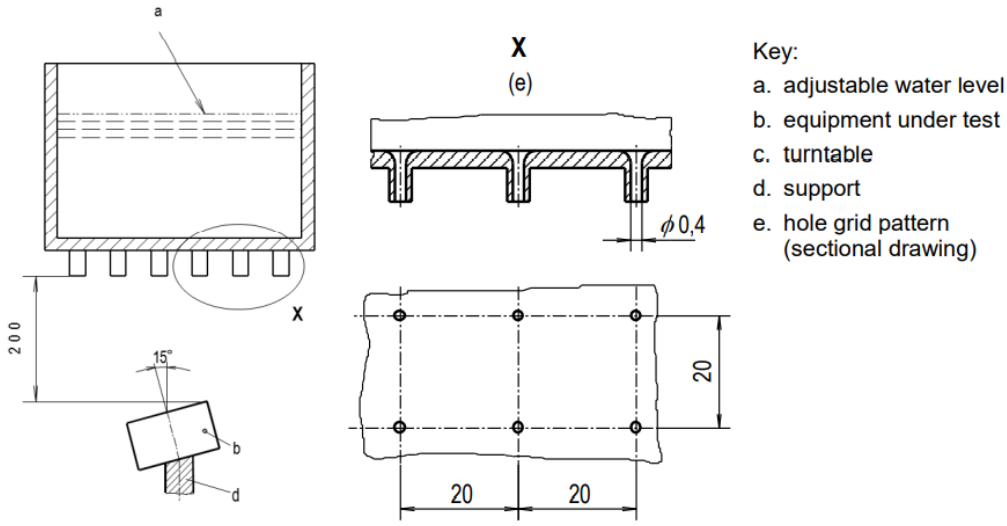
› view from the side
➔ 70° to horizontal Y



Test equipment:

CH/02 Table 3: Description of the water test equipments.

Degree of protection against ingress of water	Test set-up and spatial arrangement with reference to the equipment under test
2	Protection against vertical water drops (drip box)



Initial Evaluation of Test:

Before starting the environment test the EUTs shall pass the preceding initial measurement test IM_test (as indicated by the test flow) and may not show any mechanical damage on the visual inspection.

All parts MUST be identified and weighed (without harness and/or connector)one by one before the test and pictures of the weigh-in taken and included in the test report.

Test Procedure:

Connect original connectors to the EUT.

A. Adjust the flow rate of the drip water according the parameter given above.
B. Each EUT shall be attached to the spray chamber turntable and tested in each of the (4) fixed position(s) of 15° tilt described above.
C. The drip box shall be positioned 200 mm from the very topmost component of the EUT.
D. Subject each EUT to a uniform flow of water drops (drip water) over the entire exposed surface area for the time t1. The turntable shall not rotate during test.
E. Repeat step B to D for the remaining test positions.
F. Following the test, one of the EUT shall be disassembled for disassembly examinations.

Recovery after test:

No recovery period after CH/02 environmental test.

Immediately after the test, all the EUT shall be taken out of water and before final measurements shall be performed, all the EUT must be weighted (without harness and/or connector) one by one with pictures of the weight-in taken to include in the test report.

Acceptance Criteria:

Immediately after completion of recovery, all the EUTs shall perform:

- Functionnal examinations:
  - External Visual inspection and Mechanical inspection on all parts.
  - Intermediate electrical parametric test **at room temperature only**, class A on all parts.
- Disassembly examinations **only for selected parts** :
  - Internal Visual inspection and Mechanical inspection **only on selected parts** to examine traces of water penetration.
  - **Selected parts criterias**:
    - The part with highest weight increase.
    - Any Failed part at intermediated electrical parametric test.

After completion of examinations, all the EUTs shall perform:

- Final electrical parametric test at Toprating min, Room Temperature then Toperation max temperatures, with class A for all non-disassembled parts, and for characterization only for all disassembled-reassembled parts.

Weight the EUTs:

Weigh EUT will be done as following:

• The weight of the EUTs to be weighed without connectors before the test;
• Remove the water from the EUT surfaces
• The weight of the EUTS to be weighed without connectors after the test;
• EUTs weighing will be made with a calibrated scale tool.
• After test, EUTs must be between ± 5% tolerances.

17.3 CH/08: FLUID CORROSION

Test purpose:

The method consists in bringing various fluids into contact, for a period and at a fixed temperature, with parts liable to come into contact with the fluids occasionally, and to observe any resulting alteration.

According to agreement with the supplier, following conditions have to be determined:

- The resistance of an ECU covered with various fluids and in fluid steams according to the mission profile.
- The effects of aggressive fluids on materials.

Only 2 fluids will be tested: consumers fluids and households cleaner.

Applicable standards:

RNDS-C-00515 "BASIC PHYSICOCHEMICAL ENVIRONMENTAL SPECIFICATIONS OF ELECTRONIC PARTS Rev 3.0 (2019-09-16);
ISO 16750- 5 (2010-04-15);

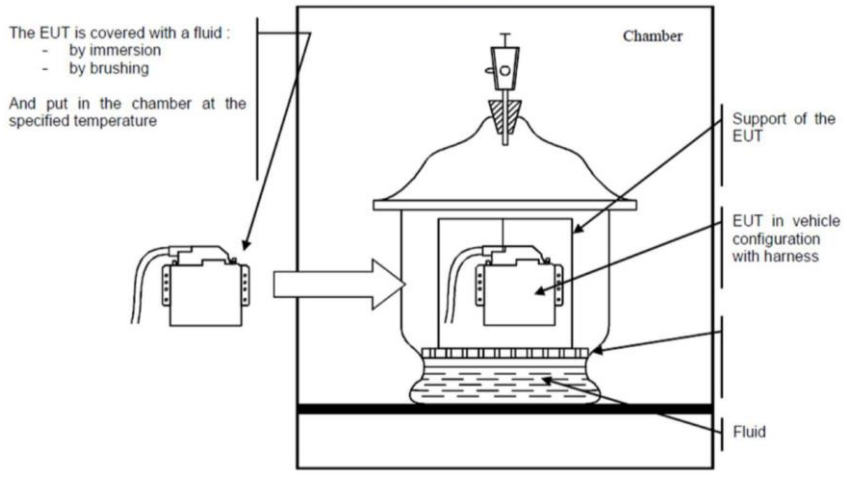
Test Parameters:

Total Test Duration	3 days
Test Duration	24h / fluid
Test Temperature	RT (Room temperature)
EUT Test Position	In-vehicle mounting orientation (See Ch 10.2)
Operating Mode	1.2
Operating class & gravity level	A´/1
Number of samples	3 (Refer to DV/PV flowchart) 2 parts for test (1 part per fluid) 1 part as a master part EUT

Note 1: This test is not intended to be a life test.
Note 2: Safety instructions and warnings for the chemicals shall be observed.

Equipment:

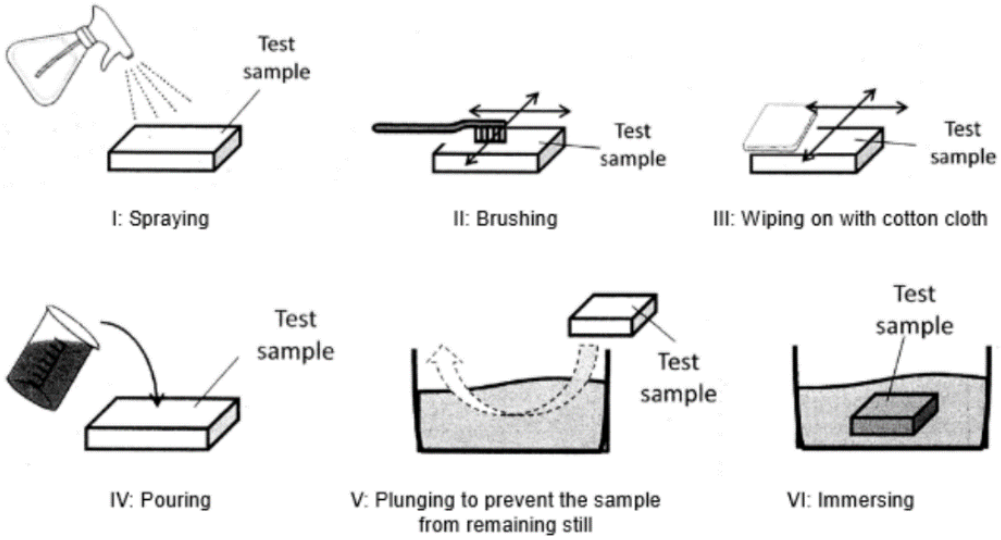
CH/08 Figure 1 : Description of the test.



Application Method:

II	**Brushing**	Immerse brush into the chemical agent fore each new side. Brush the DUT until it is completely wet. Let redundant agent drip off the DUT.
VI	**Immersing**	According to the picture below.

Explanatory notes: I: Spraying
II: Brushing
III: Wiping on with cotton cloth
IV: Pouring
V: Plunging to prevent the sample from remaining still
VI: Immersing
Tmax: Maximum ambient temperature



Initial Evaluation of Test:

Before starting the environment test the EUTs shall pass the preceding initial measurement test IM_test (as indicated by the test flow) and may not show any mechanical damage on the visual inspection.

EUT conditioning:

Unless otherwise specified, the EUT shall be stored at a room temperature (RT) of (23 ± 5) °C and a relative humidity (RH) of between 25 % and 75 % until temperature and humidity are stabilized.

Test agent conditioning:

Unless otherwise specified, all test agents shall be stabilized at an RT of (23 ± 5) °C when applied on the EUT.

Test Procedure:

Use the EUT as defined in the table below for each chemical agent.

A. Seal all connectors of the EUT with potted connectors in order to make them watertight.
B. Cover the global surface of EUT with fluid by brushing using a natural bristle brush (aluminum bristle-holder, minimum dimensions = width 6mm, bristle length 25mm. The brush can be bigger depending on product size).

C. Place the painted EUT in a sealed bottle as described in CH/08 Figure 1.
D. The EUT has to be mounted in a vehicle configuration.
E. The plate of EUT shall be with holes for the stream to pass through
F. Use a support to maintain EUT close to the top of the sealed bottle.
G. Pour enough fluid liquid at the bottom of the sealed bottle to ensure steaming (at least 5 cm at the bottom of the bottle).
H. Place the sealed bottle in a chamber previously set at the temperature specified in CH/08 Table 1.
I. Store the EUTs in the climatic chamber for the time t_1 at the temperature T (storage temperature and time for each chemical agent/EUT are indicated in the table above);
J. Leave EUT for 24h, in accordance with CH/08 Table 1.
K. Remove the chemical agents from the EUT surfaces using a dry tissue.
L. Following the test, one of the EUT shall be disassembled for disassembly examinations.

List of fluids:

CH/08 Table 1 : Proposal of an indicative lists used by R/N in its applications.

FLUID		METHOD	RENAULT			NISSAN		
No	TYPE		REFERENCE/ COMPOSITION	Fruid temp (C°+/- 2 C°)	Duration (hr)	REFERENCE/ COMPOSITION	Fruid temp (C°+/- 2 C°)	Duration (hr)
1	Electrolyte	a)	"Aqueous sulfuric acid 35%"	70	24	Sulfuric acid 34%	23 And Maximum strage temperature of EUT	24
2	Fuel -Petrol -Diesel	b)	03-50-000	23 23	24 168	NES M0133		24 24
3	Engine oil	b)	03-50-004	100, 125 or 150	24	NES M0133		24
4	Manual transmission oil	b)	03-50-004	100, 125 or 150	24	NES M0133		24
5	Automatic transmission oil	b)	03-50-004	150	24	NES M0133 NES M5090 (CVT oil)		24
6	Brake fluid	b)	03-50-004	23	24	NES M0133		24
7	Coolant	a)	03-50-004	118	24	NES M0133		24
8	Deep cold window washing fluid	b)	41-01-003	70	24	NES M0133		24
9	Power steering system fluid	b)	03-50-004	70	24	NES M5084		24
10	Consumer fluids	a)	Sodas, mineral water, etc.	23	24	Sodas, mineral water, etc	23	24
11	Household cleaners	a)	To be defined	23	24	To be defined	23	24
12	Car Wash Soap	a)	To be defined	To be defined	24	To be defined	To be defined	24

Consumer fluid used for the test is Coca-Cola.
Household cleaner used for the test is water-based.

Link with location:

CH/08 Table 2 : link with location.

FLUID		LOCATION			
No	TYPE	Engine room	Exterior	Passenger room	Trunk
1	Electrolyte	X		(X)	(X)
2	Fuel	X			
3	Engine oil	X			
4	Manual transmission oil	X			
5	Automatic transmission oil	X			
6	Brake fluid	X			
7	Coolant	X			
8	Deep cold window washing fluid	X			
9	Power steering system fluid	X			X
10	Consumer fluids	X		X	
11	Household cleaners		X	X	X
12	Car Wash Soap		X		

Acceptance Criteria:

- The EUT shall be fully functional before and after the test and all parameters shall meet the specifications. Verification is done by means of a intermediate measurement test large, IntM_large_test as per Section 11.1.1.3.
- if no damage or anomalies are found on visual inspection following the test.
- without any mechanical damage like distortions, ruptures or cracks.

If the DUT is visibly damaged, all incidents of damage shall be documented in the test report with pictures of external/internal aspect of the EUT.

17.4 CH/09: SALT SPRAY WITH HUMIDITY FUNCTIONAL ENDURANCE TEST

Test purpose:

This test is designed for devices or equipments designed to resist to a salt atmosphere, according to the chosen severity. The salt may damage the operation of parts including metal and/or non-metal materials.

This test evaluates the resistance of the ECU against the corrosive atmosphere (interaction of the salt and the humidity).

Applicable standards:

RNDS-C-00515 "BASIC PHYSICOCHEMICAL ENVIRONMENTAL SPECIFICATIONS OF ELECTRONIC PARTS Rev 3.0 (2019-09-16);

IEC 60068-2-52 Kb.

Test Parameters:

Total Test Duration	4 cycles x (2h of Salt spray + 22h of Temperature and Humidity) + 72 h storage = 168h.
Number of cycles (N)	4
Duration temperature &humidiy	22
Duration Salt Spray Solution	2h
Nominal Power Supply (U_{nom})	14 V± 0.2 V
Humidity chamber	(93 + 2 / - 3 %) with a temperature of 40 ºC ±2 ºC.
Test Temperature	RT (Room temperature)
EUT Test Position	In-vehicle mounting orientation (See Ch 10.2)
Operating Mode	3.2
Operating class & gravity level	A (Except for connectors)/0
Number of samples	3 (Refer to DV/PV flowchart)

Test Chamber:

The chamber used for this test shall be constructed of such materials that will not influence the corrosive effects of the salt mist.

According to the referenced standard, the detailed construction of the chamber, including the method of producing the salt mist is optional, provided that :

a. The conditions in the chamber are within the limits specified .

b. A sufficiently large with constant, homogeneous conditions (not affected by turbulence) is available; these conditions should not be influenced by the EUT .

c. No direct spray impinges upon the EUT.

d. Drops of liquid accumulating on the ceiling, the walls or other parts, cannot drip on the EUT.

e. The chamber shall be properly vented to prevent pressure build-up and allow uniform distribution of the salt mist. The discharge end of the bent shall be protected from strong draughts which can cause strong air currents in the chamber.

Standard reference atmosphere:

The chamber has to be in accordance with the prescriptions of CH/09 Table below that is the table of paragraph 5.2 "Standard atmosphere for referee measurements and tests" of the IEC 60068-1 - "Environmental testing – Part 1 : General and guidance" (second line, wide range), that is to maintain a humidity from 45 % to 55 % with a temperature of 23°C ± 2°C.

CH/09 Table : Standard atmosphere for referee measurements and tests

Temperature (°C)			Relative Humidity [1] (%)		Air pressure [1]	
Nominal value	Close tolerance	Wide tolerance	Close range	Wide range	kPa	mbar
20	± 1	± 2	63 to 67	60 to 70	86 to 106	(860 to 1060)
23	± 1	**± 2**	48 to 52	**45 to 55**	**86 to 106**	**(860 to 1060)**
25	± 1	± 2	48 to 52	45 to 55	86 to 106	(860 to 1060)
27	± 1	± 2	63 to 67	60 to 70	86 to 106	(860 to 1060)
[1] Inclusive values.						

Note : the close tolerances may be used for the referee measurements. The wider tolerances may be used only when allowed by the relevant specification.

Salt solution :

Solution of 5 % of sodium chloride (NaCl)

The salt used for the test has to be technically pure sodium chloride (NaCl), containing, when dry, not more than 0.1 % sodium iodide and not more than 0.3 % of total impurities.

The salt solution concentration shall be 5 % ± 1 % by weight.

The solution shall be prepared by dissolving 5 ± 1 parts by weight of salt in 95 parts by weight of distilled or demineralized water.The pH value of the solution shall be between 6.5 and 7.2 at a temperature of 20°C ± 2°C. The pH value shall be maintained within this range during conditioning; for this purpose diluted hydrochloric acid or sodium hydroxide may be used to adjust the pH value, provided that the concentrations of sodium chloride (NaCl) remains within the prescribed limits. The pH value shall be measured when preparing each new batch of solution.

Initial Evaluation of Test:

Before starting the environment test the EUTs shall pass the preceding initial measurement test IM_test (as indicated by the test flow) and may not show any mechanical damage on the visual inspection.

Test Procedure:

A. All surfaces shall be clean and free from oils, greases or other protective materials not part of the design.

B. Perform N cycles according to the parameters above.

Number of cycles	Nature of the test	Duration (h)	Temperature (°C)	Tolerance (°C)	Relative Humidity (%)	Tolerance (%)
4	Salt spray	2	25	± 10	No requirement	
	Temperature & Humidity	22	40	± 2	93	+ 2 / -3
1	Storage	72	23	± 2	50	± 5

C. For interior parts, the severity of the test is the N°3 of the standard : 1 test cycle/active.

D. Following the test, one of the EUT shall be disassembled for disassembly examinations.

Acceptance Criteria:

The EUT shall be fully functional before and after the test and all parameters shall meet the specifications. Verification is done by means of a intermediate measurement test large, IntM_large_test as per Section 11.1.1.3.

To avoid the complete drying of the oxides that could have been created because of the test, it is requested :

- either to perform the functionnal test less than 60 min after the end of the CH/09.

- either, if functionnal test cannot be performed in the next 60 min, to put samples in a climatic chamber with 50°C and 95% RH during 2 hours and then perform immediately the functionnal test;

- if no damage or anomalies are found on visual inspection following the test.
- without any mechanical damage like distortions, ruptures or cracks.

As planned for unsealed EUT configuration, in case of fluid penetration, an examination shall be made to localise the portions through which fluid penetrated into the EUT, but the final sanction is the functional examinations.

If the EUT is visibly damaged, all incidents of damage shall be documented in the test report with pictures of external/internal aspect of the EUT (especialy for connectors and PCB).

17.5 CH/12 CORROSIVE ATMOSPHERE

Test purpose:

This test determines the corrosive influence of industrial areas for operating and storage of ECUs, particularly contacts and connections, considered separately, integrated into a subassembly or assembled as a complete equipment (especially the increase of the concentration of sulfur).

Applicable standards:

RNDS-C-00515 "BASIC PHYSICOCHEMICAL ENVIRONMENTAL SPECIFICATIONS OF ELECTRONIC PARTS Rev 3.0 (2019-09-16);

IEC 60068-2-60 Ke: Flowing mixed gas corrosion test (01-06-2015)-V03;

Test Parameters:

Total Test Duration	10 days
Method	method 4 of IEC 68-2-60 Ke (see table 1)
Relative Humidity (RH)	(75 ± 3) % RH
Test Temperature	RT (Room temperature)
EUT Test Position	In-vehicle mounting orientation (See Ch 10.2)
Operating Mode	1.2
Operating class & gravity level	A´/0
Number of samples	3 (Refer to DV/PV flowchart)

Initial Evaluation of Test:

Before starting the environment test the EUTs shall pass the preceding initial measurement test IM_test (as indicated by the test flow) and may not show any mechanical damage on the visual inspection.

Test set up:

a. EUT shall not be cleaned before test.

b. Copper coupons shall be exposed with EUT in order to verify conformance of EUT. A minimum of 5 test coupons of copper shall be exposed with EUT for the same duration. Their increase in weight during the test, measured with appropriate sensitivity, shall be taken as a measure of the corrosion and as a monitor of the reproducibility and repeatability of the test.

CH/12 Table 1: Descriptions of the method 4 (IEC 68-2-60 Ke).

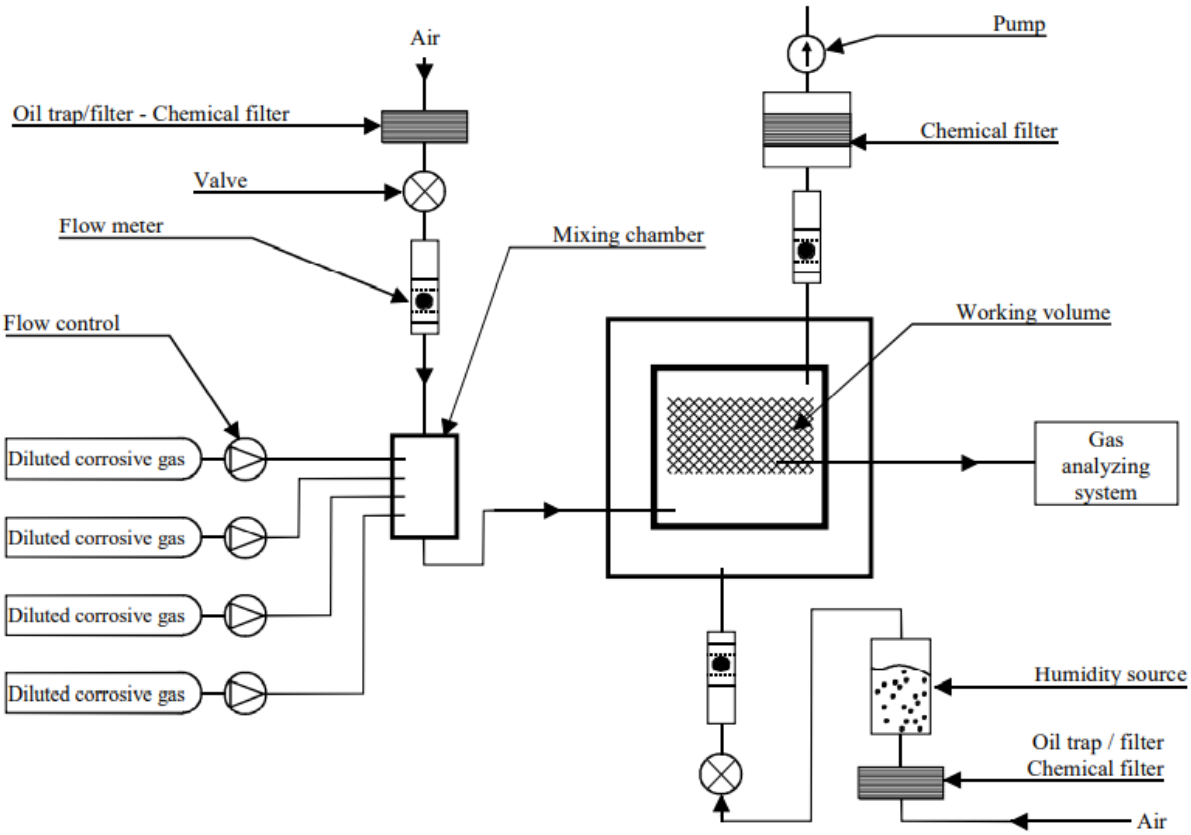
Parameters	"Method 4"
H_2S (10^{-9} vol/vol) 1)	10 ± 5
NO_2 (10^{-9} vol/vol) 2)	200 ± 20
Cl_2 (10^{-9} vol/vol) 3)	10 ± 5
SO_2 (10^{-9} vol/vol) 4)	200 ± 20
Temperature (°C)	25 ± 1
Relative humidity (RH %)	75 + 3
Number of renewal by hour	3 - 10
Weight increase of copper coupons mg / (dm^2 x day) according to annex A of the standard 60068-2-60	1.2 - 2.4

1) H_2S: 1 µg/m^3 = 0.71 mm^3/m^3
2) NO_2: 1 µg/m^3 = 0.53 mm^3/m^3 (10^{-9} vol/vol) = unite (µg/m^3)
3) Cl_2: 1 µg/m^3 = 0.34 mm^3/m^3
4) SO_2: 1 µg/m^3 = 0.38 mm^3/m^3

CH/12 Table 2: Descriptions of the severity.

Parameters	
H_2S (10^{-9} vol/vol)	10 000
Temperature (°C)	40 ± 1
Relative humidity (RH %)	90 - 95
Number of renewal by hour	3 - 10
Weight increase of copper coupons mg / (dm^2 x day) according to annex A of the standard 60068-2-60	1.2 - 2.4
H_2S: 1 µg/m^3 = 0.71 mm^3/m^3 (10^{-9} vol/vol) = unite (µg/m^3)	

Description of the bench:



Test Procedure:

A. Connect the cable from EUT connector in order to keep intact connector degradation.
B. Place the EUT in the test chamber and subject them to the mixed flowing gas environment given in the test parameters given above. Refer to IEC 60068-2-60, Method 4.
C. Following the test, one of the EUT shall be disassembled for disassembly examinations.

Acceptance Criteria:

- The EUT shall be fully functional before and after the test and all parameters shall meet the specifications. Verification is done by means of a intermediate measurement test large, IntM_large_test as per Section 11.1.1.3.
- if no damage or anomalies are found on visual inspection following the test.
- without any mechanical damage like traces of gas corrosion;

If the EUT is visibly damaged, all incidents of damage shall be documented in the test report with pictures of external/internal aspect of the EUT.

18 LIFE TESTS - LT

18.1 LT/00 : TEMPERATURE EQUIVALENT EVALUATION ΔTeq

Preliminary test - To be performed at the beginning of DV.

Test purpose:

This test is conducted to evaluate the temperature equivalent to the self heating, in order to calculate the acceleration factors for the life tests.

Applicable standards:

RNDS-C-00515 "BASIC PHYSICOCHEMICAL ENVIRONMENTAL SPECIFICATIONS OF ELECTRONIC PARTS Rev 3.0 (2019-09-16);

Test parameters:

Number of cycles (N_{cycles})	1 per activation profile
High Temperature (T_{max})	+70°C
Rate of Temperature Change (T_{Change})	+ / - 2 ºC
Nominal Power Supply (U_{nom})	14 V± 0.2 V
Temperature Reference Point	Ambient temperature (chamber temperature)
EUT Test Position	In-vehicle mounting orientation (See Ch 10.2)
Operating Mode	3.2 (HW bench)
Operating class & gravity level	A/0
Number of samples	2 (Refer to DV/PV flowchart)

Activation profiles:

Activation profile	% of vehicle lifetime (according to the method of calculation)	Air temperature	Vehicle ON? (for engine compartment and outside ECUs)
Profile 1	α1 %	Tair_1 °C	Y/N
Profile 2	α2 %	Tair_2 °C	Y/N
…		…	…
Profile 70	α70 %	Tair_70 °C	Y/N

Initial Evaluation of Test:

Before starting the environment test the EUTs shall pass the preceding initial measurement test IM_test (as indicated by the test flow) and may not show any mechanical damage on the visual inspection.

Test Procedure:

1. Firstly use an infrared camera to perform the test.
2. Close the ECU with a transparent film (from a thermal point of view) to reproduce the real condition.
3. Provide in validation report the Infra Red thermography pictures.
4. Check results of camera investigation and start measurement using thermocouples.

Test Method 1 is applied: Operate the EUT using unique activation profile to cause the maximum heat conditions which are expected during actual operation by users.

1. Associate a thermocouple to any of the hottest components/elements identified at thermography test (during CL/13 test) while performed with representative self heating.
2. Place the EUT in a thermostatic chamber in which the temperature is adjusted to room temperature.
3. Place the input unit and the load unit outside the chamber to operate the EUT.
4. Connect the input unit and the load unit to operate the EUT.
5. Associate a thermocouple to any of the hottest components/elements identified at thermography test while performed with representative self heating (worst case : 10 thermocouples x n activation profiles).
6. Increase the temperature in the thermostatic chamber gradually to Tmax.
7. After reaching Tmax, wait 1h ± 0.5h for EUT temperature stabilization.
8. Set the power supply voltage to Ua = 14 ± 0.5 V.
9. At Tmax, and for each activation profile,

- Operate EUT until each thermocouple has reached a steady temperature
- For each thermocouple, record
  - steady temperature
  - time for reaching steady temperature.

Specific requirements to complete this testing :

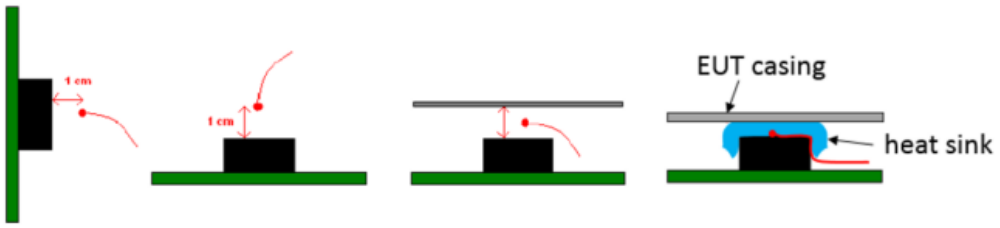
Renault require the supplier:

- To operate using all the activation profiles **to cause the heat conditions which are expected during actual operation by users.**
- To give, for each activation profile, and for each hot component/element
  - The air temperature above it;
  - The time to reach the air temperature stabilization.
- To calculate and transmit to Renault/ Nissan the ΔTeq value used for LT/01 & LT/03.

Mounting position for thermocouples:

Thermocouples have to be placed above the components, at a distance of about 1 cm.

If the housing is too close to the component, then place the thermocouple at the middle distance component-housing.



Calculation of ΔTeq:

For each component/element equipped with a thermocouple, we will have several saturation ambient temperatures Tamb corresponding to different activation profiles.

For each activation profile, retain the 3 components/elements that have the most important saturation temperatures and keep the maximum saturation ambient temperature:

$$Tamb_i = Max(Tamb_{1,i}, Tamb_{2,i}, Tamb_{3,i})$$

With : i : index of activation profile = [1; n_{pro}]

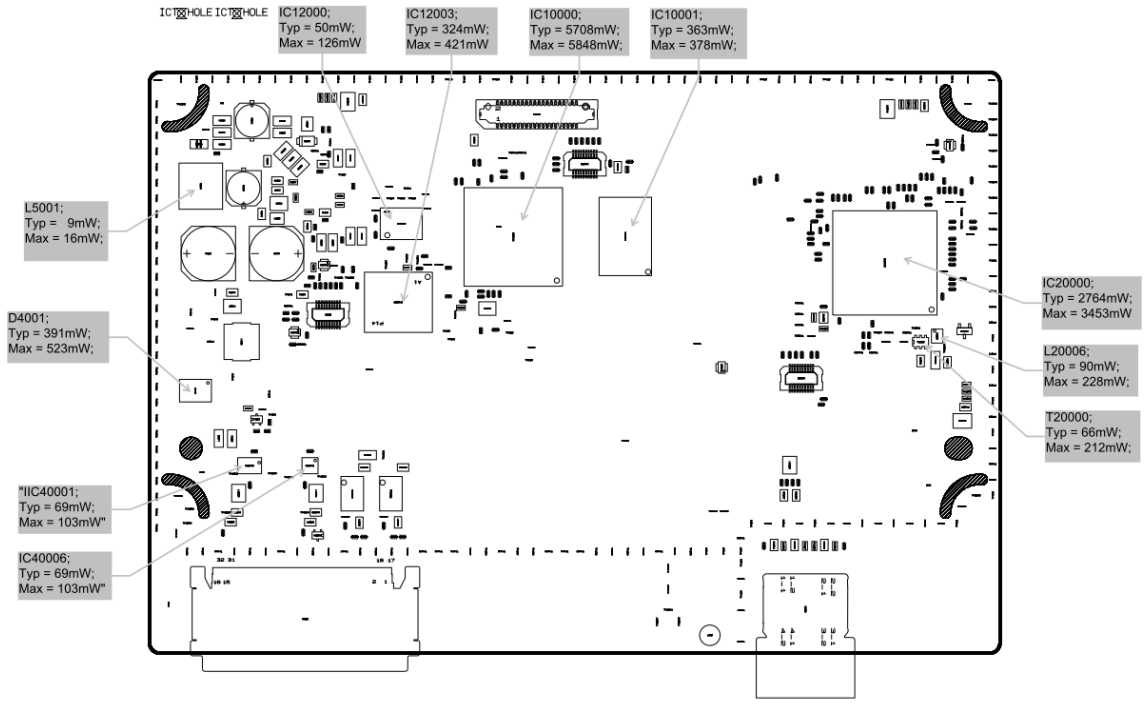
Now, for each profile, calculate the ΔT self heating temperature (ΔTeq) by subtracting the external temperature corresponding to the air temperature of the profile:

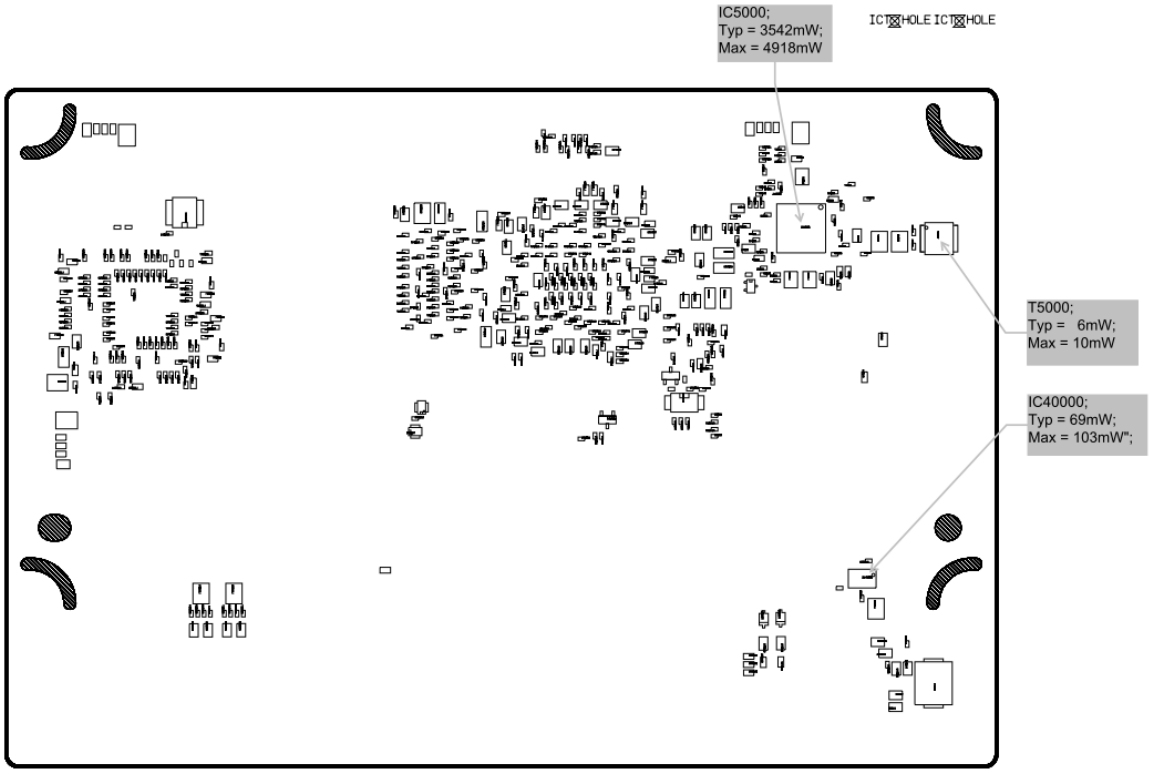
$$\Delta Teq_i = Tamb_i - Tair_i$$

Then, the calculation method of ΔTeq has to be agreed between R/N and supplier before the beginning of the test. By default, method 1 has to be applied.

Method 1 : $\Delta Teq = Max(\Delta Teq_1, \Delta Teq_2, ..., \Delta Teq_{Npro})$

Thermocouples placement :





Acceptance Criteria:

The EUTs have passed the environmental test:

- if no damage or anomalies are found on visual inspection following the test.

A documentation of all tests is necessary, especially in case of mechanical damages such as deformations or cracks are detected.

Validation report:

The following information must be given:

- a picture to see where the sensors have been located;
- the curves of these sensors to detect resonance frequency;
- table with all saturation values;
- Infra red thermography pictures for each profile;
- results of simulation if applicable;
- value of the specification compared to average temperature of element);

18.2 LT/01 : THERMAL CYCLING LIFE TEST

Test purpose:

This test generates mechanical failures (deterioration and fatigue) due to a thermal stress produced by the difference of thermal expansion coefficients between materials.

For example, these standard is applied for evaluation of:

- the soldering joints strength, the metallic interfaces strength,
- stress on a printed wiring assembly due to a coating or a molding agent,
- wire-bondings strength, etc.

Applicable standards:

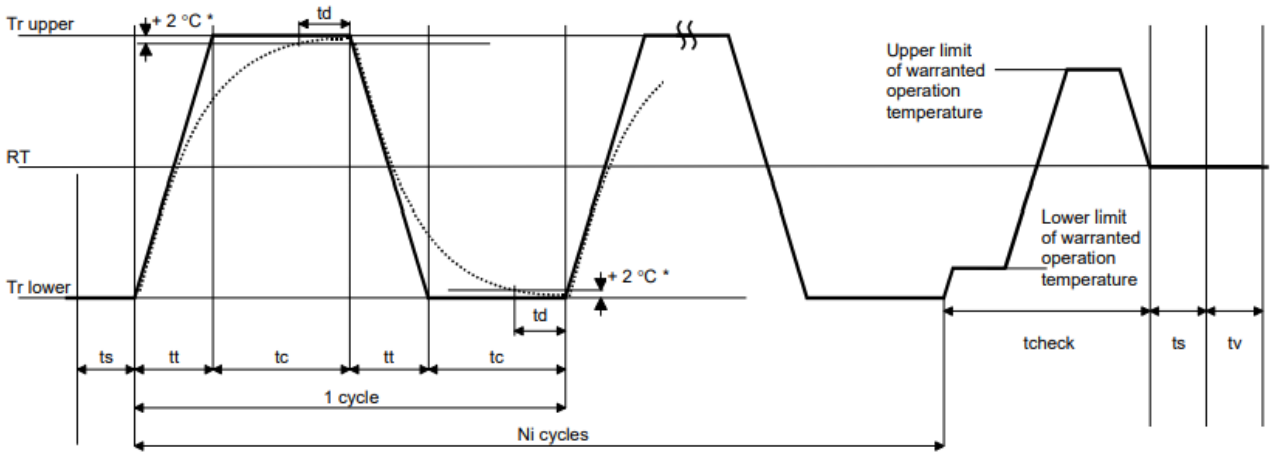
RNDS-C-00515 "BASIC PHYSICOCHEMICAL ENVIRONMENTAL SPECIFICATIONS OF ELECTRONIC PARTS Rev 3.0 (2019-09-16);

Deviations: Test performed with operating mode 1.1 instead of 1.2.

Test parameters:

Total test duration	600h =25 days
Temperature transition rate	10°C/min
Cycle duration	2*(tt+tc) = 2*(12,5+32,5) = 90 min
Transition time (tt)	tt = 125/10 = 12,5 min
Product temperature stabilization (td)	td = 15 min (according to CL00 to perform)
Soak time (tc)	tc = 32,5 min (according to CL00 to perform)
Thermal cycles to perform (N_{cycles})	400 cycles
High Temperature (T_{max})	+85°C
Low Temperature (T_{min})	-40°C
Rate of Temperature Change (T_{Change})	+ / - 2 ºC
Nominal Power Supply (U_{nom})	14 V± 0.2 V
Temperature Reference Point	Ambient temperature (chamber temperature)
EUT Test Position	In-vehicle mounting orientation (See Ch 10.2)
Operating Mode	1.1
Operating class & gravity level	A´/0
Number of samples	9 (Refer to DV/PV flowchart)

Thermal impact test pattern:



Tr upper: upper limit of warranted storage temperature.
Tr lower: lower limit of warranted storage temperature.

* Temperature deemed saturated
Target temperature - 2 °C on the hot side
Target temperature + 2 °C on the cold side

Temperature in the test chamber
EUT temperature

ts: ≥ 2 hours, or time required for specimen to have a temperature stabilized.
tv: sweep vibration check-out. (An arbitrary time of 15 min. or more in three directions)
tcheck: high and low temperature operation check-out.
(Conduct the test at upper/lower limit of warranted operation temperature, with EUT stabilized at each temperature)

tt (transition time): ≤ 30 °C/minutes
td: ≥ 15 minutes

Initial Evaluation of Test:

Before starting the environment test the EUTs shall pass the preceding initial measurement test IM_test (as indicated by the test flow) and may not show any mechanical damage on the visual inspection.

Test Procedure:

A. Set chamber temperature at (Tr lower).
B. Put equipped EUT inside chamber.
C. Wait till the temperature of the slowest component crosses (Tr lower + 2°C).
D. Let chamber at (Tr lower) for td extra time.
E. Set temperature chamber on (Tr upper) for (tt+tc) time.
F. Let air chamber increase and stabilize to (Tr upper).
G. Set temperature chamber on (Tr lower) for (tt+tc) time.
H. Let air chamber decrease and stabilize to (Tr lower)
I. Finish cycle with chamber at (Tr upper) temperature
J. Continue by performing N_{Cycle} between Tr lower and Tr upper according to the graph above.
K. The EUTs shall then remain under standard atmospheric conditions for the attainment of temperature stability.
L. Following the test, one of the EUT shall be disassembled for cross section investigation.

Specific requirements to complete this testing :

Renault require the supplier:

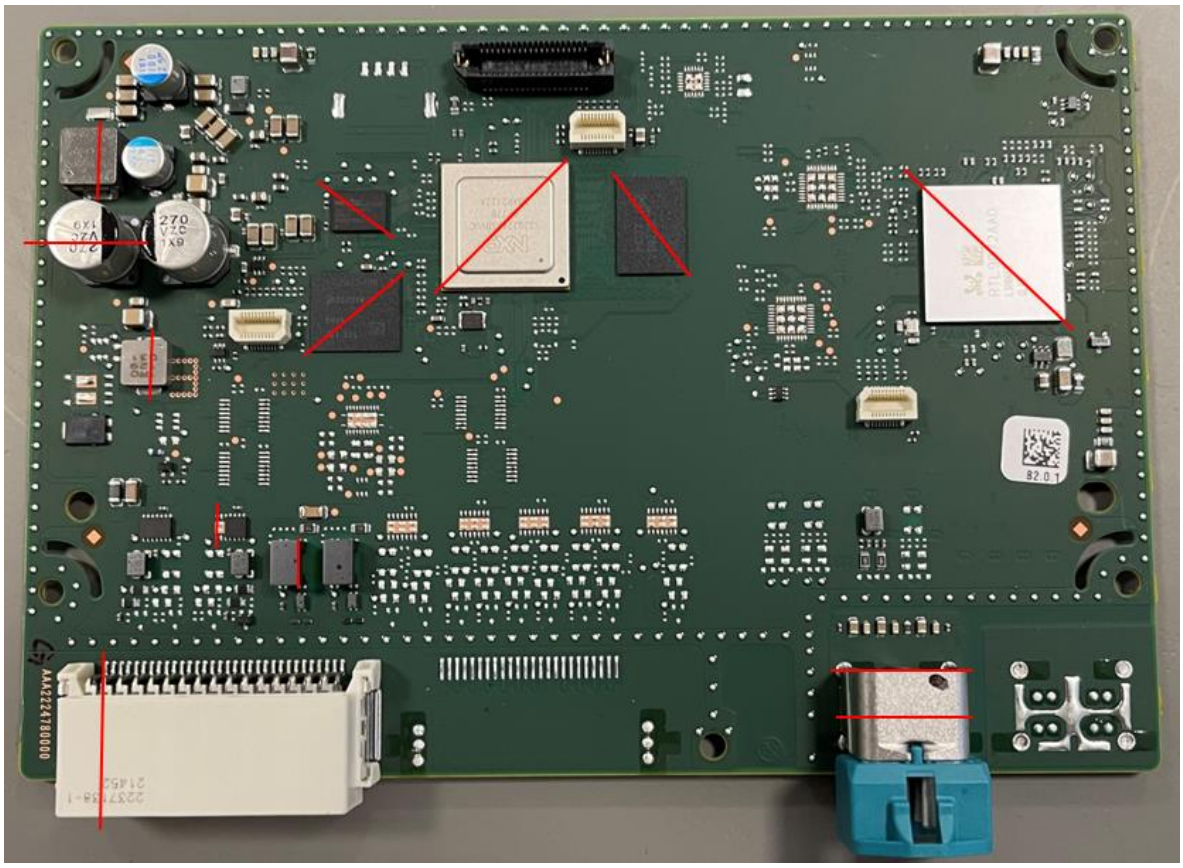
- To make two function confirmation tests.
  - The first at the end of the first part of the test ;
  - The second at the end of the second third of the test;
- To vibrate EUT by performing Confirmation Point test of VI/07 on X, Y, Z axes, 15 min per axis.
- To perform microsections on solder joints in order to detect any crack.

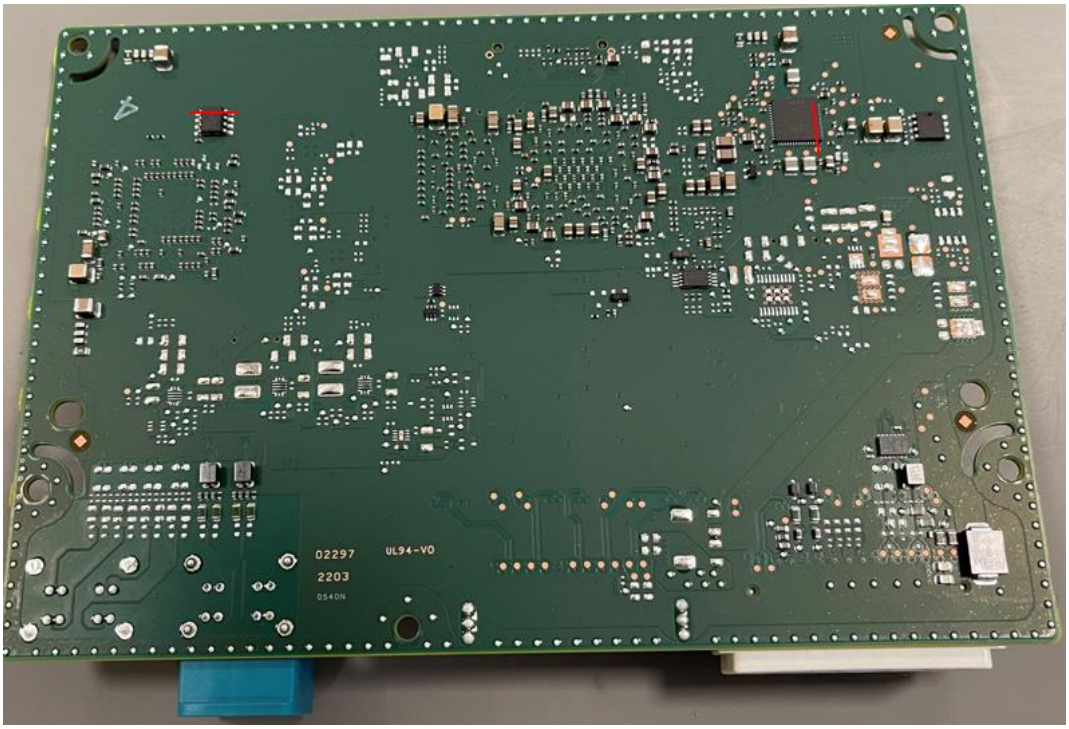
To be performed in DV and PV.

Location of the Microsection (same as CL/01) :

The location of microsection is defined following components and location in PCB.

For FACEASY PCU, it will be done on 1 part only :





Acceptance Criteria:

The EUTs have passed the environmental test:

- The EUT shall be fully functional before and after the test and all parameters shall meet the specifications. Verification is done by means of a intermediate measurement test large, IntM_large_test as per Section 11.1.1.3.
- if no damage or anomalies are found on visual inspection following the test.

Validation report:

The following information must be given:

- The real curve applied to the ECU.
- Pictures of full ECU at the end of the test to see the global aspect of the ECU (external and internal).
- Metallographic cross section of solder joints representative to each kind of process (SMD, wave ...) and representative to each kind of specific technology (BGA, PLCC, press fit…)
- For lead-free products, technical data to prove its quality. (e.g. Weibull parameters).

18.3 LT/02 : CONSTANT HUMID HEAT LIFE TEST

Test purpose:

This test generates chemical failures. This standard is applied to a combination of devices and materials that constitutes units and parts.

The combination of those different material or even combinations of chemical that are used in manufacturing processes induce chemical reactions, which both temperature and humidity may accelerate.

Such a combination can be applied to the evaluation of elements that are feared to undergo degradation or fatigue.

Knowledge of the capacity of a product to be stored, to start and to work on conditions of wet heat. Revealing in an accelerated way, some failures of a product submitted alternately to several agents of environment.

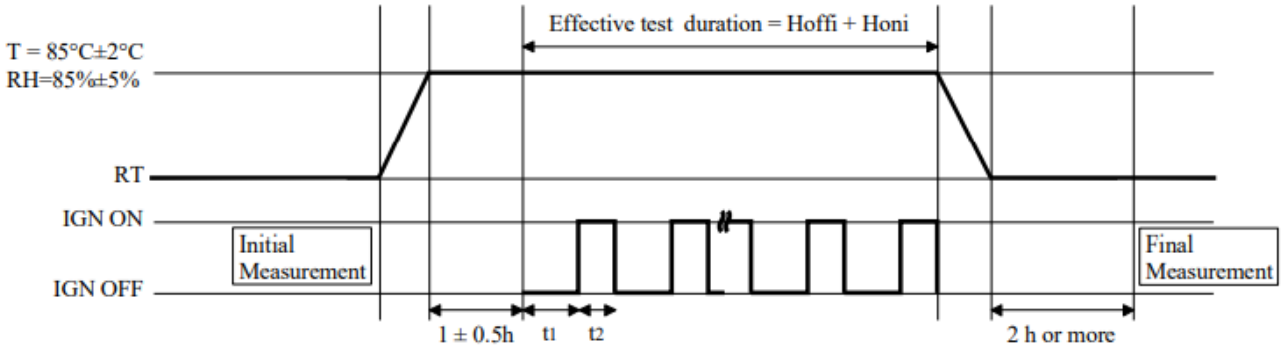
Applicable standards:

RNDS-C-00515 "BASIC PHYSICOCHEMICAL ENVIRONMENTAL SPECIFICATIONS OF ELECTRONIC PARTS Rev 3.0 (2019-09-16);

Test parameters:

Total test duration	12 h ING ON +240h ING OFF = 252h
High Temperature (T_{max})	+70°C
Relative Humidity (RH)	85%±5%
Rate of Temperature Change (T_{Change})	+ / - 2 ºC
Room Temperature (RT)	23 ± 5 °C
Nominal Power Supply (U_{nom})	14 V± 0.2 V
EUT Test Position	In-vehicle mounting orientation (See Ch 10.2)
Operating Mode	3.2/1.2
Operating class & gravity level	A/0
Number of samples	6 (Refer to DV/PV flowchart)

Test pattern :



t_1 = period equal to IGN off
t_2 = period equal to IGN on

Initial Evaluation of Test:

Before starting the environment test the EUTs shall pass the preceding initial measurement test IM_test (as indicated by the test flow) and may not show any mechanical damage on the visual inspection.

Test Procedure:

1. Use fresh and serial production representatives harnesses;
2. Set chamber temperature at room temperature.
3. Equip EUT with housing, assembly interface (fastening feature);
4. Put equipped EUT inside chamber;
5. Fix cable harnesses in car mounting representative position;
6. Operate them for INITIAL MEASUREMENT full function confirmation (mode 3.2). Stop operating and stay in 1.2 mode.
7. Set chamber at temperature of 85±2 °C and relative humidity of 85±5 %RH.
8. Leave the EUT for 1±0.5 h for stabilization in mode 1.2.
9. Continue with testing by following steps mentioned at sequence paragraph.
10. When a parametric test is required or when finishing the test
    a. Decrease temperature from T down to R.T. for 1 hour under 50% RH (to avoid condensation when opening the chamber).
    b. Leave the ECU without operating at R.T. for a period adequate for the attainment of temperature stability before parametric test.
11. Following the test, one of the EUT shall be disassembled for whiskers investigation on lead-free products.

Thermal cycle profile:

1.2 mode (showed as IGN Off above) is a static configuration, no activation is executed. No monitoring/measurement is done during this mode.

3.2 mode (showed as IGN On above) is a dynamic configuration, where activation cycle is executed. This mode is used to monitored/check the ECU functionnality.

Acceptance Criteria:

The EUTs have passed the environmental test:

- The EUT shall be fully functional before and after the test and all parameters shall meet the specifications. Verification is done by means of a intermediate measurement test large, IntM_large_test as per Section 11.1.1.3.
- If no damage or anomalies are found on visual inspection following the test.

Validation report:

The following information must be given:

- real curve applied to the EUT;
- Internal/external Visual inspection and Mechanical inspection;

18.4 LT/03 : THERMAL LIFE TEST (And combined load actuation endurance)

Test purpose:

This test generates electrical component chemical failures. Electronic parts must be evaluated in assembled conditions. Even if the elements and materials individual reliability tests are satisfied, it is difficult to judge the reliability of the components mounted on a PCB. The manufacturing process may cause chemical reactions on materials composing the unit, leading to further deterioration. So it is needed to test the reliability of the assembled ECU that is the purpose of this test.

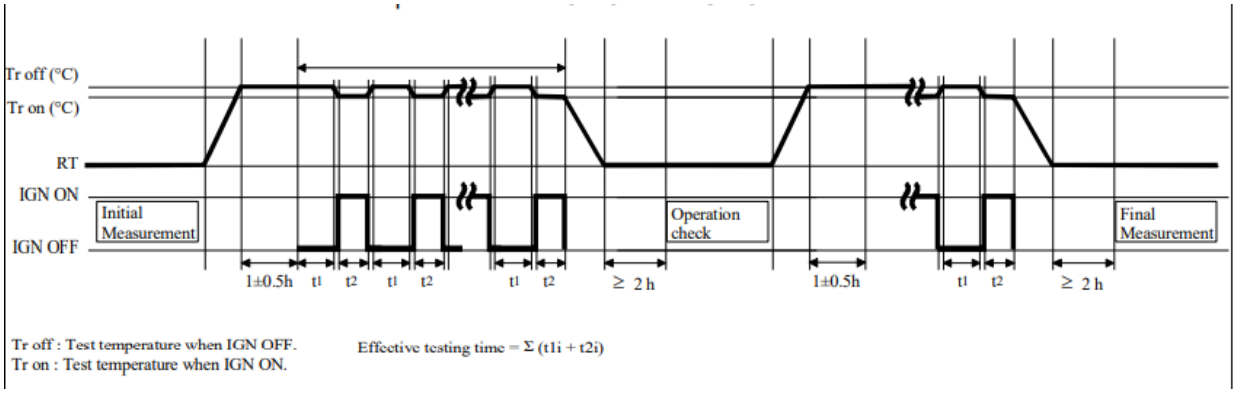
Applicable standards:

RNDS-C-00515 "BASIC PHYSICOCHEMICAL ENVIRONMENTAL SPECIFICATIONS OF ELECTRONIC PARTS Rev 3.0 (2019-09-16);

Test parameters:

Total test duration	1050h ~~44 days
Durability level	H
Mounting location code	I (inner panel instrument)
IGN On duration (hours)	768
IGN Off duration (hours)	282
Temperature parameters for Tr Off (°C)	Tr_off = +95 °C
High Temperature (T_{max})	Tr_on = +70 °C
Rate of Temperature Change (T_{Change})	+ / - 2 °C
Nominal Power Supply (U_{nom})	Unom = 14 V ±0,2V operating mode 3.2
Temperature Reference Point	Ambient temperature (chamber temperature)
EUT Test Position	In-vehicle mounting orientation (See Ch 10.2)
Operating Mode	3.2 during IGN ON 1.2 during IGN OFF
Operating class & gravity level	A/0
Number of samples	6 (Refer to DV/PV flowchart)

Thermal cycle profile:



Initial Evaluation of Test:

Before starting the environment test the EUTs shall pass the preceding initial measurement test IM_test (as indicated by the test flow) and may not show any mechanical damage on the visual inspection.

Test Procedure:

1. Use fresh and serial production representatives harnesses.
2. Set chamber temperature at room temperature.
3. Equip EUT with housing, assembly interface (fastening feature)
4. Put equipped EUT inside chamber.
5. Fix cable harnesses in car mounting representative position.
6. Raise temperature from (R.T). to (Tr off).
7. Leave the EUT without operating at (Tr off) for (1±0.5h).
8. Start operating EUT in IGN OFF mode for t_2 duration.
9. After t_2 duration, decrease temperature from (Tr off) down to (Tr on).
10. When EUT temperature has reached (Tr on), start operating EUT in IGN ON mode for t_1 duration.
11. After t_1 duration, decrease temperature from (Tr on) down to (R.T.)
12. Leave the EUT without operating at (R.T.) for a period adequate for the attainment of EUT temperature stability.
13. Perform electrical parametric test at (R.T.)
14. Following the test, one of the EUT shall be disassembled for cross section investigation.

Acceptance Criteria:

The EUTs have passed the environmental test:

- The EUT shall be fully functional before and after the test and all parameters shall meet the specifications. Verification is done by means of a intermediate measurement test large, IntM_large_test as per Section 11.1.1.3.
- if no damage or anomalies are found on visual inspection following the test.

Validation report:

The following information must be given:

- The real curve applied to the ECU.
- Pictures of full ECU at the end of the test to see the global aspect of the ECU (external and internal).
- Metallographic cross section of solder joints representative to each kind of process (SMD, wave ...) and representative to each kind of specific technology (BGA, PLCC, press fit…)

Document end

S-list Id: 14398309 **Creation date:** 19 May 2022 09:05:19

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Group: VNI CE **Category:** VNI

Sensitive information: Yes

Retention time: 2 years

Explanation: Please release QP_ENV_REN_EZ1_23_IVS_PCU_ALL_0048_V1.1 (17.05.2022) qualification program for REN_EZ1_23_IVS_PCU project.

Initiator name: Davidescu Madalina **Initiator email:** madalina.davidescu@continental-corporation.com

Initiator department: I BS **Initiator login name:** cw01\uidj1314

Signer	Function	Set type/name	Decision	S-list comments
Frayssinet Pascal (A AN S4 CC1 PM) cw01\uid26228-pascal.frayssinet@continental-corporation.com	PM	AND / TEAM	Accept 19 May 2022 10:24:53 via eSign	
Faye Pauline (A AN S4 Q) cw01\uidr3536-pauline.faye@continental-corporation.com	QMP	AND / TEAM	Accept 19 May 2022 10:32:00 via eSign	
Deininger Jochen (A HEAT CE HW EU1 MKD HPQ BNC 1) auto\deiningerj-jochen.deininger@continental-corporation.com	HW ME	AND / TEAM	Accept 19 May 2022 11:18:00 via eSign	Hello Madalina, i do not understand, why a lot of people must add a date at the end of the filename, because we are using a version history into the sharepoint and in teh document. So please remove the date at the end of the file name for the next version, tahnks.
Reinwald Martin (A HEAT CE HW EU1 MKD XFC ME) auto\reinwaldm-martin.reinwald@continental-corporation.com	HW ME	AND / TEAM	Accept 19 May 2022 09:38:04 via eSign	
Iftode Adrian (A HEAT LM IAS CE SYS EU2 IAS GD6) cw01\uidp0189-adrian.iftode@continental-corporation.com	SyTEE	AND / TEAM	Accept 19 May 2022 09:35:06 via eSign	
Davidescu Madalina (I BS) cw01\uidj1314-madalina.davidescu@continental-corporation.com	SyTEE	AND / TEAM	Accept 19 May 2022 09:34:30 via eSign	